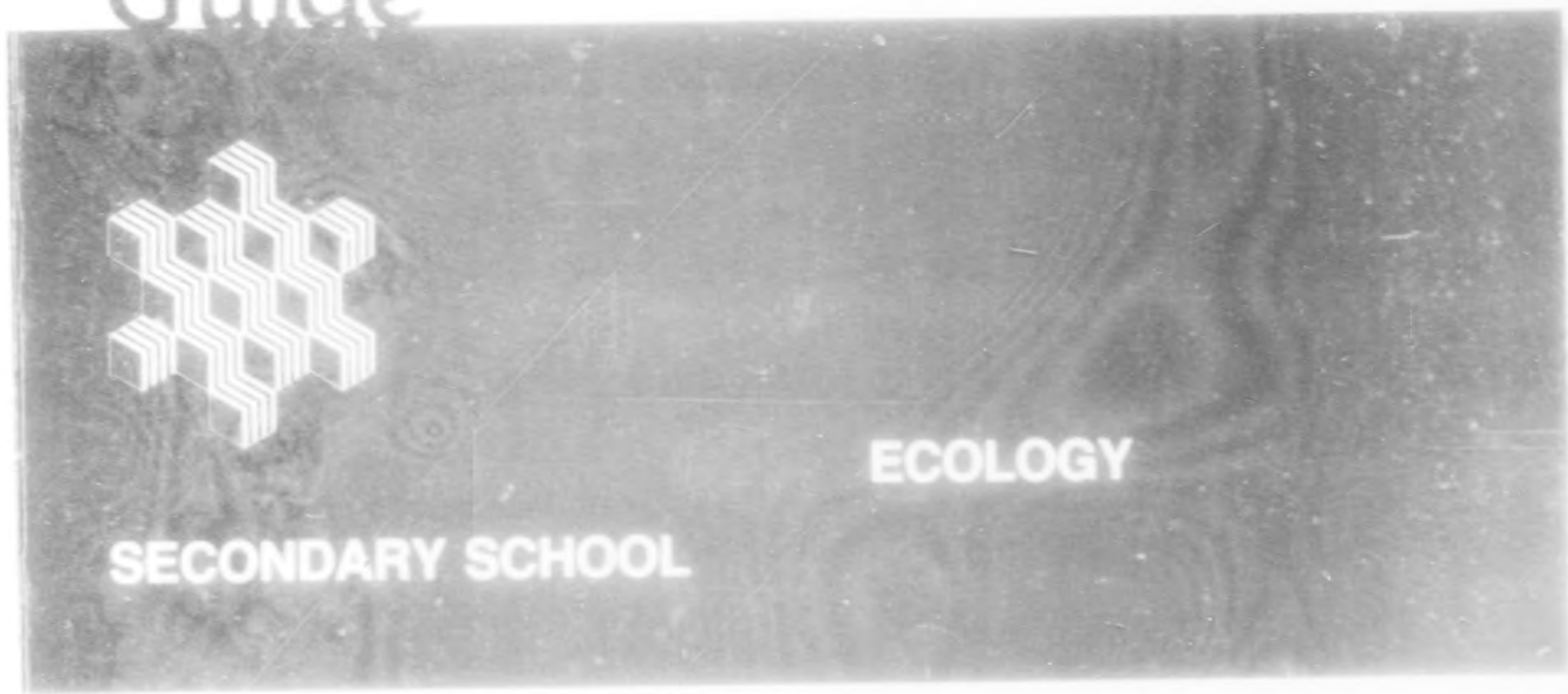
Curriculum Guide



Québec

Niveau(x) d'enseignement: 4 Numéro EDUQ : 6870755
Centre d'intérêt: 044

Ecology / Direction générale des programmes, Direction de la formation générale. -- [Québec] : Ministère de l'éducation, c1987.
213 p. ; 21 x 28 cm. -- (Curriculum guide / Ministère de l'éducation du Québec, Direction générale des programmes. Secondary school)

Code: 16-3143-02A ; 9687-777. Bibliogr.: p. 211-213.

ISBN 2-550-13573-3

Vedette(s)-secondaire(s): Québec (Province) Ministère de l'éducation. Direction de la formation générale

Descripteur(s): Guide pédagogique * Ecologie * Education relative à l'environnement * Ecole anglaise * Secondaire (Ordre d'enseignement)

Ce guide pédagogique est destiné aux enseignants qui ont à enseigner l'écologie au secondaire. Il développe dans le détail le contenu du cours dans le but d'aider à planifier les grandes lignes des cours. Il suggère une approche pédagogique dynamique et progressive qui encouragera les enseignants à personnaliser leurs propres pratiques pédagogiques. Les notes sur l'enseignement du contenu du cours et les activités d'apprentissage aideront à comprendre et à rencontrer l'objectif d'ensemble du cours. Quoiqu'un certain nombre d'activités aient été incluses dans le guide, il n'a pas été possible de répondre à tous les besoins de ceux à qui ce livre est destiné. Le guide propose un certain nombre d'activités d'apprentissage, mais son but premier est de stimuler les idées innovatrices et d'encourager les enseignants à suivre leur propre initiative et à être créateurs. Le guide comprend quatre parties: 1. l'introduction qui présente les orientations du cours, les principes de base et l'approche pédagogique; 2. les notes pour l'enseignement de chaque module; 3. les principes et méthodes d'évaluation et 4. une bibliographie sélective.

Type de document: d

EDUQ
8870755

Curriculum Guide

SECONDARY SCHOOL

ECOLOGY

Direction générale des programmes
Direction de la formation générale

© Gouvernement du Québec
Ministère de l'Éducation, 1987

ISBN: 2-550-13573-3

Legal Deposit — First Quarter 1987
Bibliothèque nationale du Québec

TABLE OF CONTENTS

	Page
FOREWORD	1
1. INTRODUCTION	5
1.1 ORIENTATIONS OF THE COURSE	7
1.2 GUIDING PRINCIPLES	9
1.2.1 An Understanding of Ecological Concepts	11
1.2.2 A Spirit of Scientific Inquiry	13
1.3 INSTRUCTIONAL APPROACH	18
1.3.1 Planning	21
1.3.2 Phases of Learning	22
1.3.3 Teaching/Learning Strategies	24
1.3.4 Motivating Factors for Twelve and Thirteen-Year-Old Pupils	32
1.3.5 Pupils' Science Notebooks	34
2. TEACHING NOTES	39
2.1 INTRODUCTORY MODULE: ECOLOGY	45
2.2 MODULE 1: INTERRELATIONSHIPS	65
2.3 MODULE 2: FUNCTIONS OF PRODUCERS	117
2.4 MODULE 3: FUNCTIONS OF CONSUMERS	175
2.5 MODULE 4: CIRCULATION OF MATTER AND ENERGY	185
2.6 MODULE 5: ENVIRONMENTAL INFLUENCES ON LIVING ORGANISMS	195
3. EVALUATION	205
4. BIBLIOGRAPHY	209

FOREWORD

FOREWORD

This curriculum guide is designed to be a practical guide for teachers. It expands in some detail on the course content with a view to helping teachers plan their course outlines and suggests a dynamic and progressive instructional approach which, it is hoped, will encourage teachers to further individualize their teaching practices. The teaching notes on the course content and the learning activities should make it easier to understand and address the overall objective of the course. While a number of different activities are included, it was not possible in the framework of this document to answer the needs of all those for whom it is intended.

The curriculum guide proposes a number of learning activities, but its primary purpose is to stimulate innovative ideas and to be an instructional support for teachers that will encourage them to follow their own initiative and be creative. It is part of the continuing efforts to revise and update science teaching that have been going on for some time.

INTRODUCTION

1. INTRODUCTION

1.1 ORIENTATIONS OF THE COURSE

It is obvious to any attentive observer that the present state of the environment requires a change of attitude and behaviour within our society. If the squandering and waste of energy and resources is to be halted, society must adopt a new approach based on genuine concern for individuals and for the natural resources of the biosphere. A philosophy of conservation must gradually replace heedless consumption. To achieve social awareness, people must develop a new attitude based on a critical appraisal of what they perceive around them. Passive acceptance, resignation, and inaction are the social consequences of human ignorance. Man has a tendency not to question the contradictory images that spring from his imagination, and to pay little attention to the reality around him.

The sciences have, to a large extent, been responsible for creating the "consumer mentality" of society. Placed at the service of man's will to power, they have contributed to the subjugation of nature. It is unfortunate that scientists have been unable to foresee the long-term consequences of their research and of its applications. Although scientists are partially responsible for the present social imbalances, this does not mean that they should be excluded from the issue; on the contrary, it is important that they be involved in seeking solutions to the problems.

For twelve and thirteen-year-old pupils, science teaching appears to be the ideal vehicle for bringing about a change in attitude. The education it provides:

- enables individuals to expand their knowledge and understanding of reality by giving them intellectual skills which will motivate them to seek, to discover, and to play an active role throughout their lives. Individuals usually appreciate and respect the things they know well, and consequently it is of the utmost importance in teaching young people to become aware of environmental problems that the teacher make sure they develop a sound understanding of basic ecological concepts. The attitude adopted by individuals towards conservation is directly proportionate to how well they understand the concepts and terminology pertaining to science and technology.

- helps to diminish the inconsistencies, the myths, and the misconceptions which, all too often, lock individuals and groups into a closed world. The acquisition of knowledge protects the individual by enabling him/her to put things into perspective, to draw up a plan of action, and to predict future developments.

The teaching approach adopted for ecology is based on the application of a scientific procedure that calls for perseverance and intellectual discipline. Jean Fourastié, whose work on the subject merits consideration, identifies three important phases of this procedure.[1] These are:

- exploring reality,
- formulating a hypothesis,
- verifying and applying the hypothesis.

---

1 Jean Fourastié, Conditions de l'esprit scientifique (coll. Idées, Éditions Gallimard, 1966) pp. 133-140.

To sum up, the main focus of science teaching should be to encourage pupils to seek the most accurate possible description of reality.

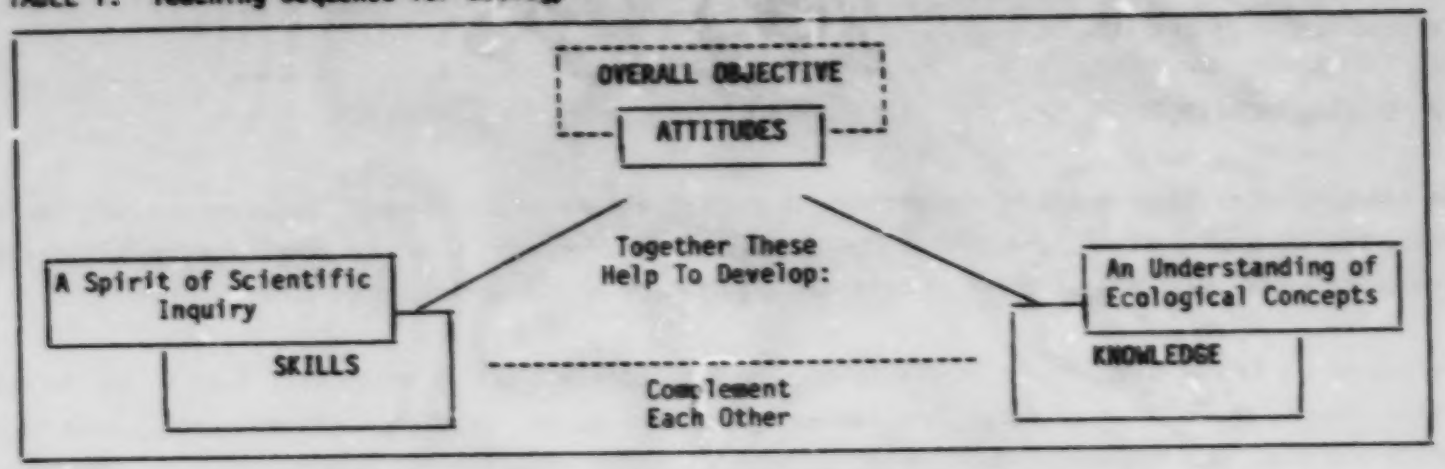
1.2 GUIDING PRINCIPLES

The teaching of ecology should be concerned with pupils' all-round development, focusing not only on intelligence, but also on emotions and will. The purpose of this course is not to condition pupils, but to help them build a new value system based on critical examination of the world around them.

The course is designed to enable pupils to acquire knowledge and skills which will lead to the formation of action groups, the sharing of ideas, and the emergence of a social conscience. Consequently, when faced with social problems, pupils will find it hard to take a neutral position by refusing to make judgements or by withholding their opinions.

To achieve these goals, two aims are pursued simultaneously: the first involves the learning of a number of ecological concepts, and the second, the development of a spirit of scientific inquiry. This dual approach integrates both knowledge and skills, as shown in Table 1.

TABLE 1: Teaching Sequence for Ecology



This sequence recognizes the importance of other than strictly cognitive objectives in educational activities. A close correlation between thought and action is necessary if pupils are to be able to build their own value systems. In the context of personal development, it is important to emphasize two specific qualities which are common to all individuals and which have, in modern times, tended to diminish in importance.

A Feeling for Nature

A feeling for nature is understood here to mean a degree of ecological awareness. This feeling is closely related to the individual's capacity to adapt to evolution and change. It is closely associated with the feeling of wonder experienced by observers of natural phenomena.

A Sense of Curiosity

Those who have a sense of curiosity are in the habit of seeking explanations of phenomena, of wanting to understand the form and function of organisms, of looking, of touching, and so on. This sense is associated with the capacity to marvel, to wonder, to find out, to learn, and to create.

1.2.1 An Understanding of Ecological Concepts

The main aim of the Ecology course is to give pupils an understanding of the basic principles or concepts of ecology. The ecosystem is the key concept in this science which involves the study of the set of interrelationships between living and nonliving things in the natural environment and how these interactions bring about exchanges of matter and energy.

Ecology is an extension of natural science: it borrows the engrossing study of plants and animals from botany and zoology. For twelve and thirteen-year-old pupils, living things are a source of interest and fascination.

The teaching of ecology involves more than the systematic study of living things: it is specifically concerned with the study of the forms and functions of life. Its purpose is to enable individuals to know, understand, and appreciate their natural environment.

Since the time when man first began to be concerned about the quality of life in his environment, there has been a growing trend in ecology to focus on the study of the problems of environmental degradation and the limits of tolerance of the natural environment. It should be remembered that the environment is not simply a part of nature; it encompasses all the relationships and interactions between man and other organisms.

In the context of the existing environmental crisis, the course attempts to develop pupils' ability to make decisions and to construct their own social ethic. In seeking solutions to the critical situation facing man, it is not enough to focus on the technical aspects of pollution: what is required is to see the problems within a global context.

Taking pollution as an example, pupils can try to ascertain whether it is related to patterns of consumption and lifestyle, or whether it is an inevitable result of all the economic development required to meet consumer needs. Both cases involve the exercise of free choice which is fundamental to all individual and group behaviours.

In order to develop ecological awareness in today's complex world, individuals and groups must acquire a sound understanding and knowledge of the subject. To this end the teaching of ecology should:

- concentrate on the basic principles, or key concepts, which individuals can apply in dealing with problems in their own environment. Pupils will show that they have learned a concept when they are able to use the terms and expressions related to this concept in formulating related statements;

- enable pupils to accumulate a quantity of relevant data for solving particular environmental problems;

- help pupils to understand that humans are an integral part of the ecosystem and that all of their actions have either a favourable or an unfavourable impact on the environment;

- include problems pertaining to a variety of environments so that pupils will gain a comprehensive picture of the environmental situation.

If pupils are to build their own value systems, they must learn to examine the root causes of situations. Given a problem, they need to look at a number of possible solutions and their consequences in light of the ideas and concepts which they have learned. Once they become accustomed to searching for the basic causes of problems, they will not be content to simply look at surface symptoms. It is very important for these future citizens to acquire the appropriate knowledge and skills if they are to be fully cognizant of their own environmental problems. Once they have mastered this knowledge, they should be motivated to take suitable action.

1.2.2 A Spirit of Scientific Inquiry

The second aim of the course is to enable pupils to develop a spirit of scientific inquiry through first-hand practical experience. The process envisaged here does not follow a set pattern or specific method. It is a progressive process which does not involve learning by imitation, but, rather, learning by practising a rigourous and systematic investigative approach. This type of approach may be broken down into a set of conditions:

a) TEACHING THAT IS CENTRED MORE ON THE PUPIL THAN ON THE CONTENT

The intrinsically interesting subject matter in ecology provides the basis for a wide range of stimulating learning situations that should elicit pupil interest and involvement and promote their social and intellectual development. Pupil-oriented teaching encourages pupils to discover many aspects of knowledge on their own. The teacher does not play the traditional role of a dispenser of knowledge. Questions, procedures, projects, and so on are more than simply means to assimilate the content of the course. Pupils begin to learn to cope without directed exercises as they solve concrete problems during the learning activities. They may initially need some direction from the teacher as they have probably had very little prior experience in working on their own. The hierarchical presentation of the content in the form of objectives is not intended to infringe on teachers' autonomy, but rather, to be of help to them.

b) TEACHING THAT FOSTERS INDEPENDENT LEARNING

Teachers should make every effort to encourage pupils to become increasingly responsible for their own learning. This is not an easy task because pupils will probably have had little opportunity to learn to study independently. Starting with a number of carefully supervised activities, teachers can gradually increase the time spent on spontaneous efforts, trial and error, and discussion. They can answer pupils' questions in ways that will encourage them to find their own avenues for exploring the concepts under study. In this way, formal teaching will gradually be phased out as pupils gradually assume more responsibility for their own learning.

Twelve and thirteen-year-old pupils have a remarkable capacity for self-directed learning, providing this aptitude is not repressed by their social milieu. For this reason, it is important that they begin to learn to take responsibility for some of their own learning as early as possible.

There will be occasions when teachers will recognize that they have to intervene so that valuable class time will not be wasted. It should be remembered that the mind functions best when presented with challenging subject matter and problems to be solved.

c) TEACHING THAT EMPHASIZES TEAMWORK

Working in a team is a valuable form of learning if the group's approach to work is serious and genuine. The effectiveness of teamwork depends on the level of satisfaction pupils experience in carrying out their tasks. If the work is stimulating, pupils will interact well together and help each other to progress.

In the interest of maintaining good class relations, the teacher should make sure that every pupil is included in a team so that no one feels left out. The number of pupils in each group and their distribution around the classroom should be conducive to a productive working climate.

d) TEACHING THAT ENCOURAGES DIALOGUE BETWEEN PUPILS AND TEACHERS

Teachers should help pupils develop greater maturity. In their role as facilitators, they should guide and support pupils' progress. Their task is to help the members of the group find their own answers to the questions they ask themselves. They should avoid imposing set opinions, so that each pupil will feel free to be as spontaneous as possible.

Knowledge is not simply an accumulation of isolated facts: it is the result of a dynamic process in which pupils' representations, or the ways in which they express their perceptions, play an important role. Teachers should pay close attention to their pupils' comments so that they can help them to clarify their perceptions. This will give pupils a feeling of security, especially if they have been in the habit of following the teacher's instructions blindly.

e) TEACHING THAT FOCUSES ON KEY CONCEPTS

Concepts are general ideas formed in the mind that help individuals develop a better understanding of reality. Pupils should be able to associate a number of subordinate notions to a key concept. These notions, as part of the key concept, reinforce and clarify it. The greater the number of notions a person is able to link to a key concept, the broader his/her understanding of that concept will be. In the process of forming concepts, it should be remembered that, while a concept expresses a certain truth, it is tentative (like all conclusions drawn in the search for knowledge) and should be viewed with reservation. There is a need for knowledge to be structured, otherwise there may be a lack of coherence between the organization of data and the facts discovered.

f) TEACHING THAT BUILDS ON INITIAL REPRESENTATIONS

Initial representations take the form of images, statements and symbols. They normally derive from pupils' experience and from their often naive perceptions. In all learning, the individual selects from among his/her representations those to which he/she can relate new knowledge for purposes of assimilation. An individual's representations reflect the degree of his/her understanding of a concept and these will be refined as his/her observations and experiences lead to improved perception. The more an individual learns about a concept, the more advanced his/her representation of it will become.

Building on initial representations is an essential part of a pupil's science education. This dimension, which is perhaps not always relevant in adult learning, can open up unexpected opportunities for discovering new concepts, facts, or phenomena.

g) TEACHING THAT IS DESIGNED TO DEVELOP SKILLS

The quality of a pupil's observation depends upon his/her ability to take measurements, to record data, to state assumptions, and so on. The creative value of a practical exercise or experiment depends on his/her ability to make educated guesses, to use imagination, and so on.

The learning value of an exercise involving the use of reference material depends upon his/her ability to organize available information. Sharing ideas through discussion is important because it helps pupils to examine problems from different points of view as they seek solutions to these problems.

These types of skills are acquired through repeated practice in learning activities. Since these skills are basically technical in nature they should be developed in conjunction with the course content so that pupils will learn how they should be applied.

h) TEACHING THAT IS FREE FROM UNNECESSARY CONSTRAINTS

If they are to be innovative, teachers need to feel that they are well supported in their jobs. Constraints, such as administrative red tape involved in obtaining approval, insufficient funds to meet needs, overloaded timetables, poorly organized laboratory or classroom space, and so on, can discourage teachers from initiating projects or developing new strategies.

Teachers need encouragement and support in developing innovative approaches or they will tend to follow traditional lines. They also need to have opportunities to discuss and share ideas with co-workers and resource persons.

i) TEACHING THAT TAKES PLACE IN STIMULATING SURROUNDINGS

It is important to ensure that the conditions in the classroom are suitable for the activities pursued. Equipment for raising animals and plants and for growing cultures, laboratory equipment, resource materials, all serve to enhance the atmosphere in the classroom. Pupils derive a great deal of satisfaction from being in a classroom that is attractive and well organized.

To ensure optimum use of the equipment, the teacher should plan its arrangement so that it will be both functional and readily accessible.

j) TEACHING THAT MAKES EFFECTIVE USE OF COMMUNITY RESOURCES

For ecology teaching to be truly effective, the teacher must make use of the local environment. It is through direct contact with their environment that pupils will become aware of existing problems and come to understand them. Regardless of the region in which the school is located, every area has interesting and worthwhile places for study, such as the schoolyard, a lane or alley, an abandoned field, a thicket, or a forest.

Pupils work more effectively when teachers develop learning activities that require them to participate actively. Teachers should make it clear that outings have a specific purpose and are not purely recreational activities. On field trips, pupils should learn to leave behind no evidence of having been there. For example, they should refrain from destroying wild life or collecting specimens except in the fall when leaves may be obtained without harming the environment; it is important for them to learn that nature should be treated with respect.

k) TEACHING THAT IS SUPPORTED BY EFFECTIVE EVALUATION

Evaluation should provide information which enables pupils to identify their strengths and weaknesses and which helps teachers and parents measure pupils' progress. To be fair, evaluation must take pupils' interests and abilities into account. Evaluation should also assess the attitudes that lie behind pupils' reactions to environmental problems and to their consequences for the future.

The preparation of measurement instruments is not an easy task. It is important that these instruments measure the pupils' capacity to examine and solve problems and their ability to apply a number of practical skills, rather than their ability to retain a predetermined amount of knowledge.

1.3 INSTRUCTIONAL APPROACH

The primary aim in teaching ecology is to help pupils develop a positive attitude towards conservation of the natural environment. This raises a number of questions: How can this broad goal be attained? How can teaching influence pupils? How can pupils achieve the anticipated learning outcomes?

First, two definitions are in order:

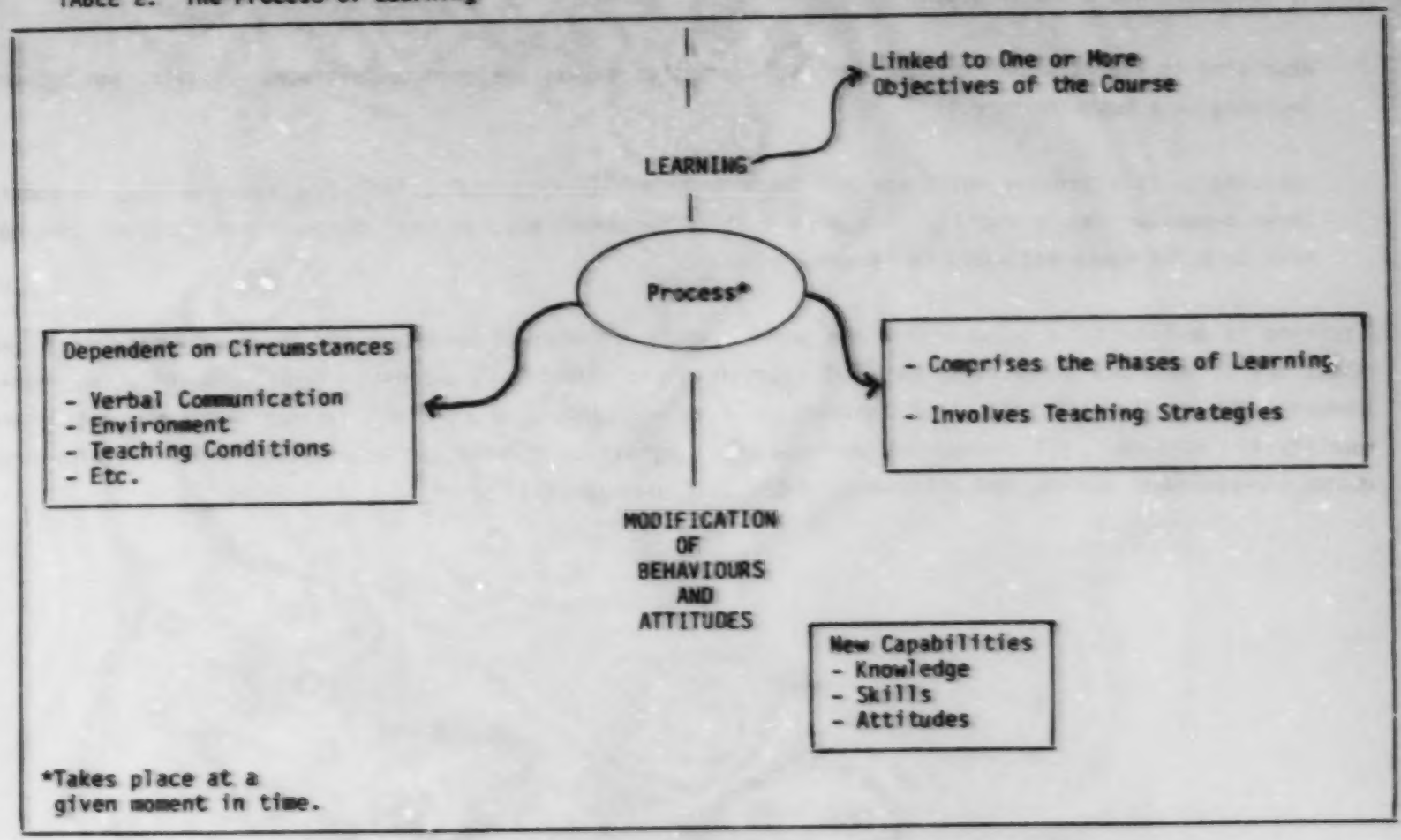
> According to Robert Gagné, instruction is "the set of events designed to initiate, activate, and support learning in a human learner."[1]
>
> Learning... is a process which enables these organisms [many animals, including human beings] to modify their behaviour fairly rapidly in a more or less permanent way, so that the same modification does not have to occur again and again in each new situation.[2]

Learning is an internal process within the pupil. While a number of predetermined learning events may bring about one or more new behaviours, external conditions can affect this process. Verbal communication, environment, the conditions under which instruction is given, and so on, are all factors which can modify the quality of learning. All changes in performance or behaviour involve the acquisition of new abilities in terms of knowledge, skills, and attitudes. Table 2 illustrates this process.

---

1 Robert M. Gagné, Essentials of Learning for Instruction (New York: Holt, Rinehart, and Winston, 1974.) p. 3.
2 Gagné, p. 5.

TABLE 2: The Process of Learning



1.3.1 Planning

Since the learning envisaged for pupils is closely linked to the objectives of the course, the learning process should be carefully planned. In planning their courses, teachers can draw on many varied topics of interest in order to develop dynamic and original teaching approaches.

One of the teachers' main tasks is to select and organize activities for their pupils.

For this purpose, they should:

- draw up a course plan (included in this document are activities for several modules which may be useful to teachers when they draw up their course plans);
- plan each of the different learning phases;
- identify the teaching strategies they will use;
- understand the motivations of 12 and 13-year-old pupils;
- plan to have pupils keep science notebooks.

1.3.2 Phases of Learning

Learning occurs at "the moment in time" when changes take place within the pupil.[1] Gagné says that the "moment" of a specific instance of learning involves a series of events: the phases of learning. Robert Brien[2] has retained three of the eight phases in Gagné's theory, namely: motivation, acquisition, and performance.

Motivation

In this phase the teacher should awaken pupils' interest and pique their curiosity, because pupils learn well when they are suitably motivated. The teacher can use incentive activities designed to kindle pupils' interest by appealing to their liking for the extraordinary, the fantastic, the spectacular, the strange, and the evocative.

In practice, this phase can take different forms:

- a short activity which involves an anticipated reward if a given behaviour is achieved, e.g. finding a photograph of a sportsman in an exciting setting to illustrate the concept "living thing";
- a short activity which builds on pupils' initial representations;
- a short presentation on what pupils will learn about a given subject;
- an overview of the objectives of the course;
- a stimulating exercise following projection of a short film or slide show of a general nature.

---

1 Gagné, p. 25.
2 Brien, Robert, Design pédagogique - Introduction à l'approche de Gagné et de Briggs (Ste-Foy: Éd. St-Yves Inc., 1981).

Acquisition

The second phase is the acquisition phase in which learning per se takes place. In practice, it can assume different forms.

An activity which facilitates acquisition should:

- develop an element of content which is directly related to the objective;
- concentrate on the skills and knowledge which pupils should master;
- make use of teaching strategies which will stimulate pupils' interest.

Performance

In this phase, pupil performances that demonstrate what has been learned provide concrete evidence that a behaviour has been modified as a result of the acquisition phase. In practice, the teacher ascertains whether pupils have mastered the basic skills and knowledge required to achieve the objective by assessing their responses in performance activities.

Performance activities should focus primarily on knowledge and skills. They should include a variety of appropriate means designed to enable pupils to assimilate the behaviour in question.

N.B. The evaluation* of a pupil's performance is a judgement which should take into account the set of events or conditions under which the learning took place. Within this framework, the teacher must try to make a satisfactory assessment of attitudes.

E.g. A pupil who has completed a germination experiment and has learned how to construct a graph to illustrate this phenomenon will find it easy to go on to subsequent experiments. This is evidence that the pupil has not only acquired new knowledge and skills, but also that his/her attitude has changed.

---

* Evaluation is an essential part of teaching/learning. Examples of forms of evaluation are included throughout the modules. See also Chapter 3.

1.3.3 Teaching/Learning Strategies

The instructional approach suggested for ecology encompasses a variety of teaching/learning strategies. The choice of strategies will depend upon the circumstances, the specific subject matter to be taught, and more particularly, the aims of the teacher.

A number of strategies that are particularly well suited to the study of ecology have been selected. These are listed below, each followed by a brief definition to give teachers a clear idea of their purpose.

a. Field Investigation
b. Laboratory Investigation
c. Demonstration
d. Research
e. Guided Class Discussion
f. Oral Presentation
g. Audiovisual Presentation
h. Dramatization
i. Written or Oral Report
j. Worksheet Activity
k. Community-Based Project or Activity

a. FIELD INVESTIGATION

Field investigations involve practical, concrete exercises designed to give pupils opportunities to discover facts through observation and manipulation. These investigations are accomplished outside the laboratory and classroom.

Investigations normally entail a step-by-step procedure, or a set of questions or instructions. This guided approach gives both the teacher and the pupils a feeling of security. However, if the goal is to have pupils learn for themselves, the procedure used must give them opportunities to observe and to discover on their own. It should encourage pupils to think and reason for themselves, rather than to simply absorb information provided by the teacher. To achieve these aims, the procedures used should change progressively during the course of the year, starting with exercises involving imitation, and working gradually towards ones which stress personal initiative. If students are already quite independent, this gradual shift will occur more rapidly.

Field investigations include outings, visits to tourist attractions (zoos, aquariums, etc.), surveys, interviews, and so on.

N.B. Outdoor studies do not necessarily have to focus on gathering material; they should also encourage pupils to observe living things.

b. LABORATORY INVESTIGATION

This strategy involves recreating suitable conditions for observing and carrying out hands-on activities that will enable pupils to discover concepts for themselves. Too often, observation and practical exercises include set procedures which leave very little room for the pupil to display initiative. Instead, pupils should be offered progressively challenging investigations. However, this strategy is largely ineffective if its aim is memorization of predetermined knowledge and facts; it then risks becoming a teaching device that is of little value to pupils. The aim of investigations is to have pupils make their own discoveries and evaluation should therefore focus primarily on these discoveries.

Laboratory investigations become an even more valuable learning aid when pupils are encouraged to repeat their investigations for the purpose of checking the results or the procedure that was followed.

This strategy involves experimentation, reproducing the environment, and so on.

c. DEMONSTRATION

Demonstrations normally combine laboratory investigations with presentations for purposes of efficiency. This strategy is used to verify results obtained by deduction or by reasoning and to help pupils discover concepts and understand them well. To this end, the teacher should try to identify the logical sequences that will enable pupils to build their knowledge step by step.

Pupils learn from watching a model demonstration because they are able to see choices being made during the activity and so become aware of what should be done as well as what should be avoided. However, this strategy can serve inadvertently to maintain and even reinforce pupils' dependence on the teacher if the latter uses it primarily as a means of transmitting knowledge, and if evaluation focuses on memorized concepts rather than ones "discovered" by pupils themselves.

Demonstrations have greater learning value when their purpose is to question the procedure or the results, or when they cover questions on which predictions can be made. Identification of the possible choices provides a basis for further work. Observation and hands-on activities are integral to this teaching strategy. Audiovisual aids are occasionally used to show different facets of the steps followed in the demonstration.

d. RESEARCH

This strategy helps pupils develop other skills needed to discover facts, because, like experiments, reference materials are sources of ideas, knowledge, and enrichment. Knowledge is acquired through a broad variety of activities.

Research activities should focus on a specific question or problem. The effectiveness of an activity will depend on how the questions or problems are formulated. The more precise the questions, and the more they correspond to the text of a given book, the easier it will be for the pupil to find the correct information. Care must be taken, however, to make sure that pupils do not become accustomed to always finding the complete and exact answer every time they consult the suggested material, because this rarely happens in scientific research outside the classroom.

Research sometimes involves consulting reference material to find additional information for observation and investigative activities. It may also involve consulting the necessary reference material to do an in-depth study on a particular topic or to find ideas for questions or activities. When doing research, pupils may use any available books, journals, specific audiovisual materials, pamphlets from government agencies, and so on.

e. GUIDED CLASS DISCUSSION

This teaching strategy involves the use of questions designed to help pupils draw on their prior representations or intuition to discover given facts. It has the advantage of stimulating the interest and active involvement of the group. It can be used to motivate pupils at the beginning of a lesson or during class deliberations.

The success of this strategy depends upon the type of questions asked. The more pupils are given clear and specific questions, the less likely they are to fail to cover important aspects of the objective adequately or to pass over basic information on the topic under discussion. On the other hand, if the goal is to establish an open dialogue between the teacher and pupils and to encourage pupil initiative, precise questioning is not the best technique to use. Instead, depending on circumstances, the teacher may, for example, use photographs that illustrate contrasting situations, multi-purpose audiovisual materials (film, etc.) that lead to discussion, poster-making of discoveries and informal group activities for the purpose of exploring specific topics.

f. ORAL PRESENTATION

This strategy involves talking about a given topic, with or without audiovisual aids. The pupils' role is to listen and to take notes as needed. Presentations should be clear and well thought-out. Provided that this type of strategy is not overused, it is a good way for the teacher to emphasize certain skills and knowledge, particularly when the class has reached an impasse in an activity, or before an examination. A short lecture often gives pupils a feeling of security. The teacher should, however, make every effort to avoid projecting the "all-knowing dispenser of truth" image.

It is a good idea to use complementary aids to make the presentations as interesting as possible. Specific-purpose materials should be used, such as transparencies, slides, film loops, three-dimensional models, posters, and textbooks.

g. AUDIOVISUAL PRESENTATION

This strategy enables teachers to show pupils events and facts that are not readily observable, or investigations that are difficult to perform for various reasons. A wide range of audiovisual aids may be used for many purposes.

To ensure that presentations effectively sustain pupils' attention, they should be pertinent to the subject under study and should not be too long. Audiovisual resources should be integrated into the educational process and become, like textbooks, accepted learning aids.

Before showing a film, the teacher should identify the main points of interest, tell pupils what to watch for, define key words, and explain any difficult terms. When appropriate, he/she can stop the film as needed to describe particular phenomena or to ask for pupils' comments. To ensure that pupils pay close attention to the film, the teacher can prepare a set of written questions for them to answer after the showing.

There are two types of audiovisual aids. The first are specific-purpose materials designed to provide precise, clear, instructional information (slides, transparencies, film loops, 16 mm films). The second are multi-purpose materials designed to create an atmosphere which will encourage members of a class to express themselves and to reflect on a given behaviour or attitude (slides, sound tapes, 16 mm films).

h. DRAMATIZATION

This strategy combines the processes of learning and decision making. It helps pupils to assimilate data and to learn more effectively. Relevant real-life or imaginary situations are used to lead the individual to make the best possible decision with regard to a problem to be solved. This technique is most effective when it focuses on the values, behaviours, perceptions, and lifestyles of the pupils.

By building on pupils' initial representations, this technique helps them to understand and express their way of perceiving and appreciating their environment. Through dramatization, individuals are usually able to perceive their own behaviours more clearly, to reflect on them and, in time, to modify them. The situations to be acted out should be authentic and set in a realistic context, otherwise, there is a danger that the process might reinforce the "push-button" image which pupils tend to have of science and technology.

Dramatization involves problem solving, games, case studies, and so on.

i. WRITTEN OR ORAL REPORT

This teaching strategy may also be used as a form of evaluation. Pupils are expected to record facts, perceptions, and information orally or in writing. This type of exercise is normally associated with observation and hands-on activities, or specific exercises which involve consultation of reference material.

These exercises are more effective if pupils are helped to express their perceptions clearly, using drawings and diagrams when necessary. Pupils should be discouraged from copying extracts from reference books. This strategy includes reports on outings, laboratory experiments, long-term investigations, and so on.

j. WORKSHEET ACTIVITY

This teaching strategy is used primarily in the performance phase. Pupils are given a set of short-answer questions which are often accompanied by a diagram, figure, or photograph. Sometimes the answers to these questions involve drawings, cutouts, and so on.

Worksheet activities are most effective when they are introduced after an acquisition activity. They should be used in moderation to avoid giving pupils the impression that they are being continually evaluated. These exercises are associated with stimulus-response learning and in the long run tend to become tedious.

This strategy involves the use of workbooks, programmed instruction, self-evaluation exercises, and so on.

k. COMMUNITY-BASED PROJECT OR ACTIVITY

The success of a project depends on the participants' ability to find relevant solutions to problems at every stage in its realization. For pupils to develop this ability, they will need both skills and knowledge even though the skills may appear to be of secondary importance.

This strategy calls for individual creativity and considerable imagination. Examples of projects that pupils might carry out are a science fair, environment week, fauna week, and a clean-up-the-environment campaign.

1.3.4 Motivating Factors for Twelve-and Thirteen-Year-Old Pupils

Teachers should be cognizant of pupils' needs and seek ways to motivate them, as necessary. The teaching experience, then, becomes a process of guiding pupils and adapting teaching/learning strategies in order to maintain and possibly increase pupils' motivation. The following are some of the motives common to this age group:

a. NEED TO BE APPRECIATED

On twelve and thirteen-year-old pupils' scale of values, physical and social achievements are sometimes more important than intellectual ones. They may feel that their learning achievements are less important than being appreciated as a person and accepted by their peers.

b. NEED TO BE CHALLENGED

In facing challenges, pupils have an opportunity to compare themselves with others. Teachers should provide pupils with challenges that are within their scope and to do this they will often have to suggest simulation and game activities.

c. AN INTEREST IN THE MARVELLOUS

Pupils are responsive and interested in things which are out of the ordinary: they are attracted by the "marvellous." Appealing to pupils' imaginations is a good way to motivate them.

d. NEED TO FEEL A SENSE OF ACHIEVEMENT AND SUCCESS

Pupils need to feel that they are progressing and to have concrete confirmation of this progress. In responding to this need, the teacher should make sure that he/she does not "short-circuit" the learning process. Prerequisites should be attained first and then the learning sequence should be gradually implemented.

e. NEED TO PRODUCE

Pupils of this age are basically interested in concrete activities. Many of them have not yet reached the formal operations stage. Most twelve and thirteen-year-old pupils do not work simply for the sake of working: their work must have a purpose. Their efforts should lead to concrete results which both they and others can appreciate. They should not work just "to please the teacher."

At this age, the need to accomplish is strong, and teachers should build on this need, providing appropriate learning contexts that will enable pupils to learn and not merely to keep busy.

f. NEED TO BE RESPONSIBLE

Pupils feel that they are capable and they want to assume responsibilities. They are not yet ready for extensive responsibility such as planning their own program for the year, but they like to feel responsible for some aspects of their studies, such as choosing topics for research and increasing their rate of work. Pupils like it when the teacher shows confidence in them by giving them extracurricular responsibilities.

g. NEED FOR VARIETY

Teachers should keep in mind that twelve and thirteen-year-old pupils' powers of concentration vary, depending on the individual, his/her interests, and the particular moment in time. To meet their need for diversity and to avoid fragmented learning, the teacher should provide a variety of learning situations so that pupils can work on several topics at a time.

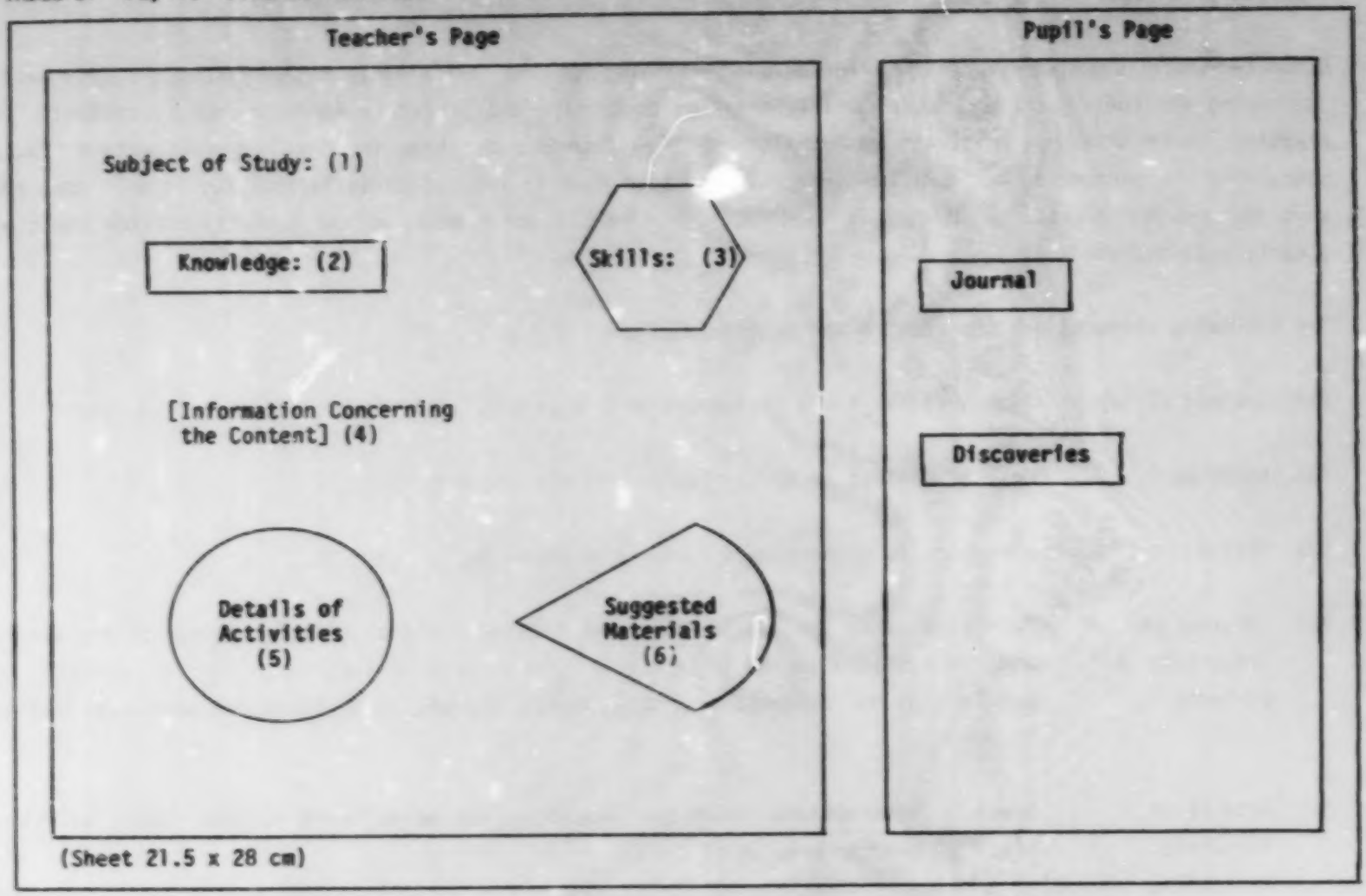
1.3.5 Pupils' Science Notebooks

Basic Principle:

Science is not limited to the acquisition of data or knowledge, it is, rather, a way of thinking. In studying science, each individual should observe as accurately as possible the living things around him/her with an inquiring mind.

In keeping with this principle, pupils' science notebooks should have two parts - the teacher's page and the pupil's page - as shown in the following table.

TABLE 3: Pupils' Science Notebook



The Teacher's Page:

Normally there are two types of information pertaining to the teaching/learning process: information concerning the content to be covered and information concerning the procedure for learning the content. For example, in an activity involving observation of a phenomenon, the teacher might suggest certain "facts" concerning the phenomenon and then may indicate to pupils "how to record" these facts. Pupils will then know what the teacher expects of them. In Table 3, the elements which make up the activity-outline sheet are clearly distinguished.

The following elements are included on the teacher's page:

(1) Subject of Study: A provocative title that highlights a particular attitude, value, belief, etc.;

(2) Knowledge: Related content to be covered during the activity;

(3) Skills: Abilities to be developed during the activity;

(4) Information Concerning the Content: Details showing the link between the related content, the key concept of the module, and the other elements developed. These details should not be too specific nor should they be exhaustive: they should stimulate questions and encourage reflection;

(5) Details of Activities: Specific instructions about the procedures to be followed so that pupils will know what the teacher expects of them;

(6) Suggested Materials:

- Books (titles, page numbers)
- Worksheets (topic, number)
- Self-evaluation sheets (topic, number)
- Audio-visual materials (title)
- Other.

The Pupil's Page:

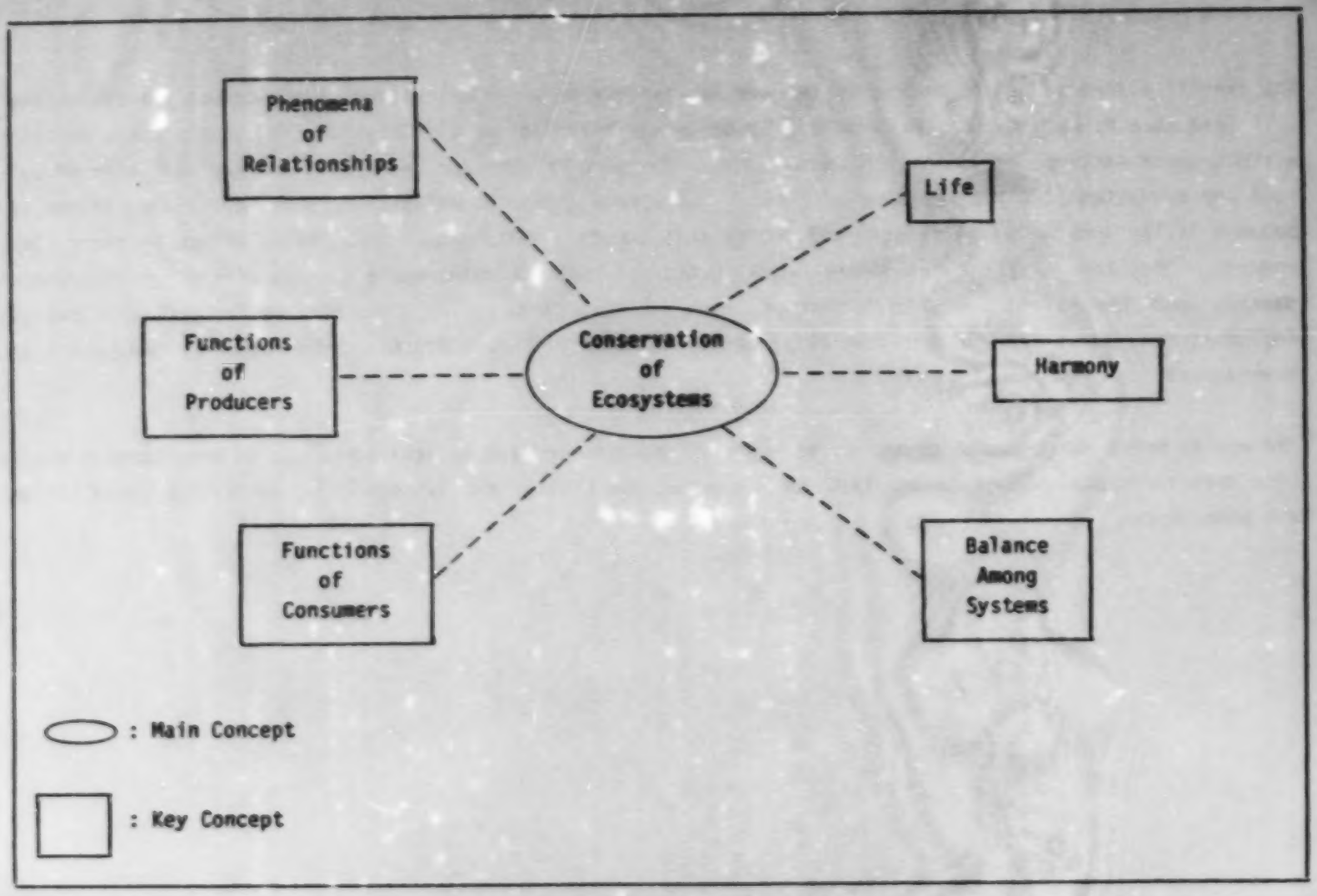
Teachers can ask pupils to use these pages as a journal for recording daily entries about facts, events, or problems which they encounter as they learn.

Pupils can also record any interesting findings or discoveries and note any specific data or conclusions which their teacher might suggest.

Exercise sheets, information taken from reference sources, etc., should be attached to the pupil's page.

N.B. The format for pupils' science notebooks that is outlined here is offered as a suggestion only. Teachers should devise their own notebook format to suit their particular needs.

TEACHING NOTES

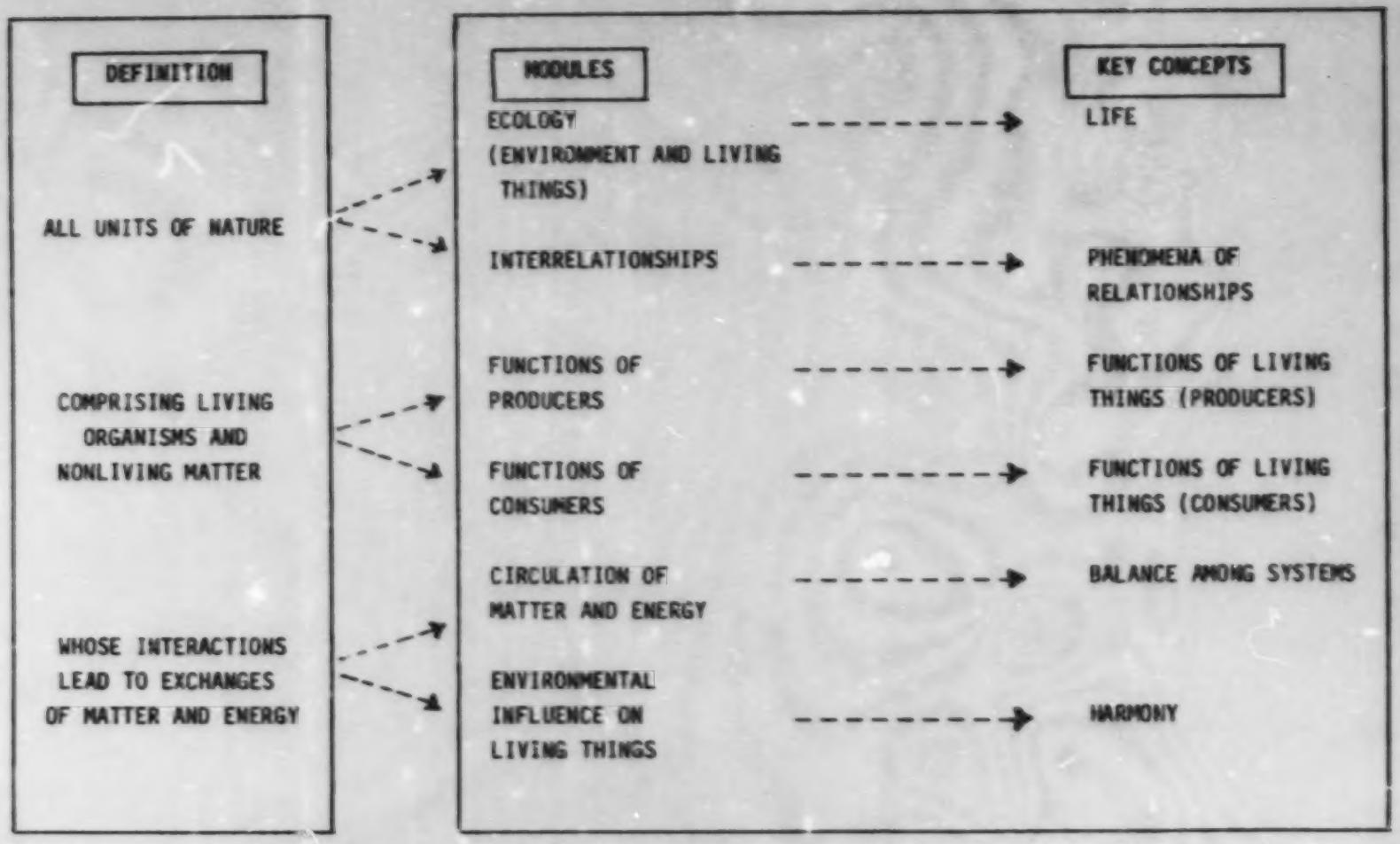

Phenomena of Relationships
Life
Functions of Producers
Conservation of Ecosystems
Harmony
Functions of Consumers
Balance Among Systems
: Main Concept
: Key Concept

THE MAIN CONCEPT: "Conservation"

The overall objective of the course is to have pupils develop an understanding of ecological principles that will lead them to work towards an increasingly conserver-oriented society in which individuals would be happy without undue wastage, pollution, or consumption. "Conservers" are consumers with a broad and informed outlook who understand the real meaning of "life." They know about the relationships between living things and between living and nonliving things, and are able to identify the functions of living things in their environment. They know that the environment is a system and that the maintenance of life within the environment depends upon the balanced use of matter and energy. They know, too, that the survival of all species, including man, is contingent upon the existence of a harmonious relationship between living things and the environment.

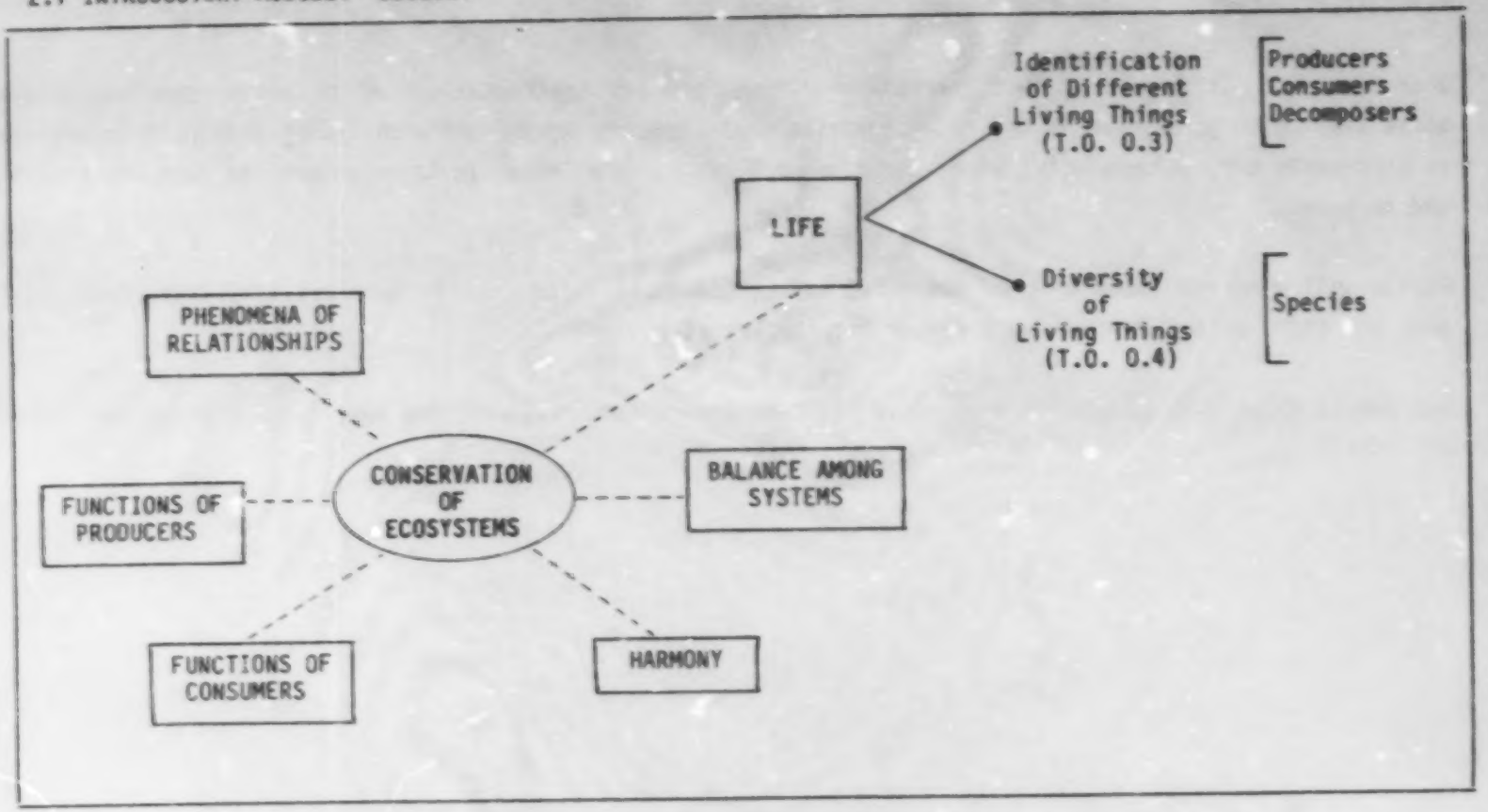
The way to bring about social change is to begin by changing individual attitudes. It is only through education that individuals learn to reassess their conduct and habits and, subsequently, to develop new attitudes and behaviours.

ECOSYSTEM ----------> CONSERVATION



INTRODUCTORY MODULE: ECOLOGY

2.1 INTRODUCTORY MODULE: ECOLOGY



KEY CONCEPT: LIFE

What is life? It is a difficult concept to define, and yet manifestations of it can be seen everywhere. While the capacity to move is the characteristic most commonly associated with living things, this criteria is inadequate and, consequently, others must be used, such as the capacity to reproduce, to feed, to breathe, and to grow.

Pupils will find out about life by observing living things in nature. Life does not simply manifest itself here and there at the whim of the observer; it thrives everywhere.

For pupils to be able to develop a positive attitude toward conservation, they have to understand the concept of "life."

TABLE OF STRATEGIES FOR THE INTRODUCTORY MODULE: ECOLOGY

Intermediate Objectives \ Teaching/Learning Strategies	A Field Investigation	B Laboratory Investigation	C Demonstration	D Research	E Guided Class Discussion	F Oral Presentation	G Audiovisual Presentation	H Dramatization	I Written or Oral Report	J Worksheet Activity	K Community-Based Project or Activity
0.1.1 to 0.1.3					*	*	*				
0.2.1			* 2		* 1						
0.3.1	* 4				* 3					* 5	
0.4.1 to 0.4.2	* 8			* 7	* 6						

LEGEND: *: Suggested teaching/learning strategy
Nos. 1-8: Activity numbers

CONTENT	TERMINAL OBJECTIVE: 0.1 - 0.3	LEARNING ACTIVITIES
In ecology, the natural environment, in which diverse organisms have specific functions, is distinguished from the human environment in which man, with his arsenal of ways to effect change, functions. The environment is made up of living and nonliving things. Living things have certain common characteristics, but they also have their own unique and individual features. Living things include producers, consumers, and decomposers. At first glance, the diversity of their ways of eating and moving gives the impression that they are very different.		At the beginning of the course, the term "environment" is used instead of ecosystem, because pupils find the latter a more difficult concept to grasp. The teacher should build on pupils' prior knowledge in developing the ideas presented in the introduction. Pupils will, for instance, have difficulty understanding the term "species," if the teacher does not build on their current perception of its meaning. Learning in this module involves the development of the skill of knowing how to record data, observations, etc. In looking for similarities and differences, pupils will discover the main characteristics of a living thing, of a producer, etc. When the concepts in this first section have been covered, the teacher should not immediately introduce others, such as photosynthesis, the food chain, etc., because these will be studied later in the course. Teachers may ask pupils questions which will challenge them to examine phenomena with a critical eye. For example: Is coral a living thing? Is a branch alive after it has been cut from a tree? The teacher can use activities concerned with the limited reliability of the senses. Optical illusions make particularly amusing exercices. In introducing pupils to science, it is very important that the teacher encourage them to question and to doubt appearances. **Example 1: MOTIVATION ACTIVITY FOR OBJECTIVE 0.2.1** **TOPIC: Appearances Can Be Deceiving** **Focus of Learning:** Working method for science.

CONTENT	TERMINAL OBJECTIVE: 0.2	LEARNING ACTIVITIES
There is an astonishing diversity of living things. Species are differentiated by unique characteristics and they are able to transmit, unchanged, their own distinctive forms and structures to their offspring.		**Time:** 15 - 35 minutes. **Materials:** Pictures of optical illusions. **Teaching Strategy:** Guided Class Discussion, see Section 1.3.3(e). **Procedure:** Present or project pictures showing phenomena of optical illusions. Initiate a discussion about these phenomena: . How can our eyes give us unreliable information? . Is it our eyes that are at fault? . Is it possible for our eyes to perceive inaccurately? . Our sense of touch? Etc. **Example 2:** ACQUISITION ACTIVITY FOR OBJECTIVE 0.2.1 **TOPIC: Appearances Can Be Deceiving** **Focus of Learning:** Working method for science. **Skills:** To be able to recognize the limitations of sensory perceptions. **Time:** 30 - 40 minutes. **Materials:** Containers, thermometers.

CONTENT	TERMINAL OBJECTIVE: 0.2	LEARNING ACTIVITIES
		Teaching Strategies: Demonstration and Guided Class Discussion, see Section 1.3.3(c) and (e). **Procedure:** Prepare the following: . 2 containers filled with cold water . 2 containers filled with hot water . 1 container filled with water of unknown temperature. Ask 4 pupils to take part in this experiment: . Have 2 pupils place their right hands in the container of hot water for at least 1 minute. . At the same time, have the other 2 pupils place their right hands in the container of cold water. . Next, have all 4 pupils place their right hands in the container filled with water of unknown temperature and ask them whether the temperature of the water is cold or hot. Initiate a discussion: . Why do we get different responses from different pupils? . Is this a reliable technique for measuring temperature? . Etc. Have other pupils do the experiment.

CONTENT	TERMINAL OBJECTIVE: 0.3	LEARNING ACTIVITIES

Questions:

- Did you analyze the steps performed?
- What should be done to avoid errors?
- Is it worthwhile using measurement instruments?
- Do you know anyone who is doing or has done scientific research?

Example 3: MOTIVATION ACTIVITY FOR OBJECTIVE 0.3.1

TOPIC: Living Things

Focus of Learning: Components of the environment.

Time: 10 - 15 minutes.

Materials: A short film, an extract from a longer film, or a series of slides which show a given environment.

Teaching Strategy: Guided Class Discussion, see Section 1.3.3(e).

Procedure: Show the film or slides.

Initiate a discussion:

- What are the properties of living things?
- How can you tell that a given organism is a living thing?
- How can you tell that a given object is a nonliving thing?
- Etc.

CONTENT	TERMINAL OBJECTIVE: 0.3	LEARNING ACTIVITIES

Example 4: ACQUISITION ACTIVITY FOR OBJECTIVE 0.3.1

TOPIC: Living Things

Focus of Learning: Components of the environment.

Skills: To know how to record similar and dissimilar characteristics.

Time: 30 - 40 minutes.

Materials: A variety of samples, magnifying glass.

Teaching Strategy: Field Investigation, see Section 1.3.3(a).

Procedure: Have pupils form teams of two.

Take them out into the schoolyard to collect or to observe interesting objects.

Have them observe an object.

Ask them to record one characteristic specific to this object and one more general characteristic that is similar to characteristics of other objects.

Ask pupils to note another specific characteristic of the same object.

N.B. Make sure that, in collecting samples, pupils do not cause damage to the environment.

CONTENT	TERMINAL OBJECTIVE: 0.3	LEARNING ACTIVITIES
	Questions:	. In your observations, did you discover any characteristics that you had never noticed before? . Did you use a magnifying glass?
	Example 5: PERFORMANCE ACTIVITY FOR OBJECTIVE 0.3.1	
		TOPIC: Living Things
	Focus of Learning:	Components of the environment.
	Skills:	To know how to record similar and dissimilar characteristics.
	Time:	20 minutes.
	Materials:	Worksheets (as follows).
	Teaching Strategy:	Worksheet Activity: see Section 1.3.3(j).
	Procedure:	Give pupils a self-evaluation exercise and a list of words to be used for filling in the blanks: . Pupils should cover the right-hand column, which gives the answers. . They should read the statements slowly and fill in the blanks. . As they move to the next statement, they check their answers. . Indicate to the pupils that there may be synonyms for their answers that they may wish to discuss with the teacher and fellow pupils.

CONTENT	TERMINAL OBJECTIVE: 0.3	LEARNING ACTIVITIES

WORKSHEET

Living/Nonliving

1	A tree surrounded by the main elements required for its survival is in its	environment
2	A plant or a tree would have suitable ..... if its environment included all the necessary elements to ensure its survival.	conditions
3	When a plant develops normally in its environment, it means that it has	suitable conditions
4	If an organism has four legs and muscles, it can be said that it has ..... which make it capable of movement.	structures
5	An organism which has muscles also has ..... which make it capable of movement.	structures
6	An organism which must move to satisfy its needs has structures which make it capable of	movement
7	An organism with limbs or muscles has ..... which make it capable of	structures movement

CONTENT	TERMINAL OBJECTIVE: 0.3	LEARNING ACTIVITIES	
	8	A dog can swallow food; it has the capacity to	absorb
	9	Any organism that is able to absorb food has the capacity to	nourish itself
	10	If a puppy is becoming heavier and/or bigger, it is	growing
	11	An organism which is becoming heavier and/or bigger is	growing
	12	A puppy can grow because its digestive system can ..... food.	absorb
	13	A maple tree can grow because its roots can .....the nutrients required for its growth.	absorb
	14	An organism is capable of growth if it has the .....required to enable it to ..... the elements needed for growth.	structures absorb
	15	A pair of mice produce young mice; they have .....that enable them to reproduce.	structures

CONTENT	TERMINAL OBJECTIVE: 0.3	LEARNING ACTIVITIES	
	16	A bean can grow into a bean plant; it has ..... that enable it to reproduce.	structures
	17	Small mice resemble their parents; they are ..... of their parents.	replicas
	18	If parents are capable of making replicas of themselves, they have structures that enable them to	reproduce
	19	Observe an organism that is in an environment suitable for its survival and see if it can move. If it does, it is	alive
	20	If it cannot move, see if it is growing. If it is growing, it is	alive
	21	If it cannot move or grow, try to find out if it is capable of reproduction. If so, it is	alive
	22	If it cannot move, grow, or reproduce, it is a ..... substance.	nonliving

CONTENT	TERMINAL OBJECTIVE: 0.3	LEARNING ACTIVITIES
		Give pupils a short post-test after they have completed the self-evaluation exercise: E.g. . Give three reasons why an apple is a living thing. . Give three reasons why water is a nonliving substance. . Etc. . Encourage students to discuss their answers and any alternative terms they may have found. **Evaluation:** Pupils should be able to name the characteristics of a living thing and a nonliving thing. They should also be able to match facts with characteristics. **Example 6:** MOTIVATION ACTIVITY FOR OBJECTIVES 0.4.1 and 0.4.2 **TOPIC: Diversity Among Living Things** **Focus of Learning:** Species. **Time:** As required. **Materials:** Short film or slides on plant and animal species in a given environment. **Teaching Strategy:** Guided Class Discussion, see Section 1.3.3(e).

CONTENT	TERMINAL OBJECTIVE: 0.4	LEARNING ACTIVITIES

Procedure: Show the film or slides.

Initiate a discussion:
- Do you know these organisms?
- Have you seen them before?
- Why have these organisms been given names?
- Why do they have different names?

Example 7: ACQUISITION ACTIVITY FOR OBJECTIVES 0.4.1 AND 0.4.2

TOPIC: Diversity Among Living Things

Focus of Learning: Species.

Skills: To know how to record similar and dissimilar characteristics.

Time: Variable.

Materials: Plant specimens (leaves, flowers, bark) of several different species.

Teaching Strategies: Guided Class Discussion and Research, see Section 1.3.3(d) and (e).

Procedure: Put the specimens out for pupils to observe.

Initiate a discussion:

- All of these plants are different in some way. (Give an example.)

CONTENT	TERMINAL OBJECTIVE: 0.4	LEARNING ACTIVITIES
		. All of these plants are similar in some way. (Give an example.) Ask pupils to select two specimens which have a different characteristic (form or shape) and to draw them. The previous step may be repeated, if desired. . Why does a given specimen have a name? . How can you tell that a given specimen is a member of a species?
		Example 8: PERFORMANCE ACTIVITY FOR OBJECTIVE 0.4.1 **TOPIC: Diversity Among Living Things** **Focus of Learning:** Species. **Skills:** To know how to record similar and dissimilar characteristics. **Time:** 15 minutes. **Materials:** Worksheets, newspapers. **Teaching Strategy:** Field Investigation, see Section 1.3.3(a). **Procedure:** Organize a field trip in an area where pupils can collect leaf specimens.

CONTENT	TERMINAL OBJECTIVE: 0.4	LEARNING ACTIVITIES

Have pupils take double sheets of newspaper in which to dry the specimens they collect.

N.B. In the fall, leaves may be collected without harming the environment.

Prepare a worksheet (as follows).

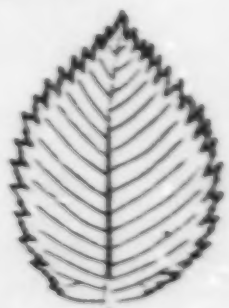
WORKSHEET

Identifying different species

*Find an example of each of the leaves illustrated below.
*Lay out your specimens on a newspaper.
N.B. Put your name on your newspaper.

General structure

a) simple leaf



b) compound leaf

- name a similarity

- name a difference

CONTENT	TERMINAL OBJECTIVE: 0.4	LEARNING ACTIVITIES
		2. Leaf edge a) notched leaf b) smooth leaf - name a similarity - name a difference
		3. Leaf form a) leaf not lobed b) lobed leaf - name a similarity - name a difference

CONTENT	TERMINAL OBJECTIVE: 0.4	LEARNING ACTIVITIES

4. Other

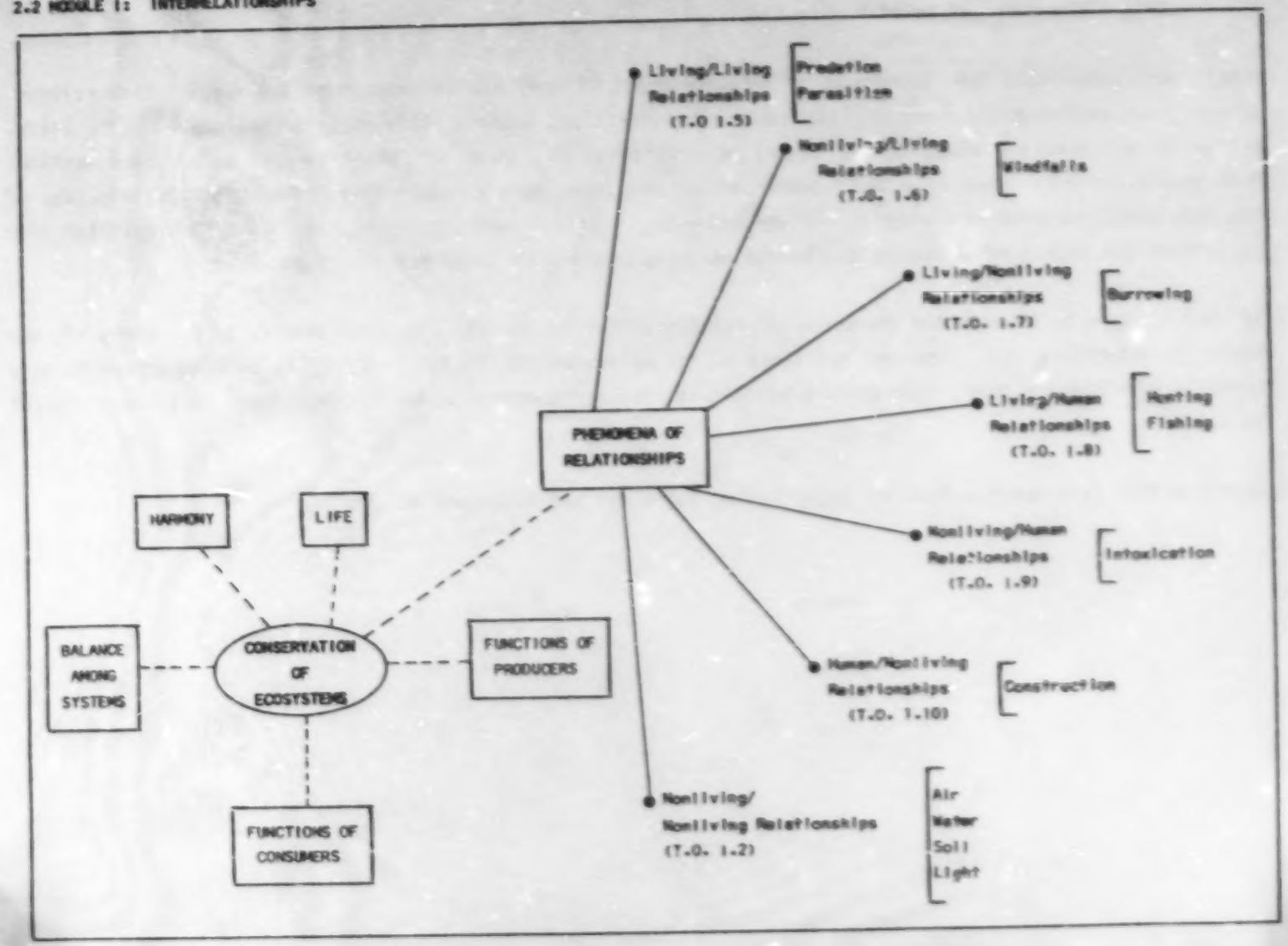
QUESTIONS:
. Observe one of the specimens and show why it belongs to a specific species.
. Do you think this specimen can change any aspect (form, etc.) of its appearance from year to year at will? Have you any proof?

Drawings courtesy of: Plantes médicales et comestibles, Centre d'interprétation Les Palissades, Service de l'Éducation en conservation, Ministère Énergie et Ressources, Québec.

Evaluation: Evaluation should focus on pupils' ability to give a simple definition of the word "species." Pupils could be asked to illustrate this rather abstract concept with examples.

MODULE 1: INTERRELATIONSHIPS

2.2 MODULE I: INTERRELATIONSHIPS



KEY CONCEPT: **"Phenomena of Relationships"**

Pupils must understand the "phenomena of relationships" if they are to understand and support conservation. In any given environment, everyday life involves interactions among a whole range of phenomena. This interaction is not always obvious to the casual observer, but it can be discerned through careful observation. Most people are only aware of a small number of the phenomena that surround them. Their lack of knowledge of the relationships between living things and between living and nonliving things makes it difficult for them to foresee the impact of technological change or to maintain a balanced set of values.

If pupils learn to observe the phenomena of relationships first-hand, they will develop an awareness of, and begin to understand, the forms and functions of the environment. To this end, it is more important to have pupils understand the basic interactions between the different elements, rather than learn about each element in detail.

Understanding this concept involves appreciating the forms and functions of life.

TABLE OF STRATEGIES FOR MODULE 1

Intermediate Objectives \ Teaching/Learning Strategies	A Field Investigation	B Laboratory Investivation	C Demonstration	D Research	E Guided Class Discussion	F Oral Presentation	G Audiovisual Presentation	H Dramatization	I Written or Oral Report	J Worksheet Activity	K Community-Based Project or Activity
T.O. 1.1											
1.1.1 to 1.1.4	* 2				* 1					* 3	
T.O. 1.2											
1.2.1 to 1.2.4	5*6 7				* 4	* 8				* 8	
1.2.5 to 1.2.6		*9 *10 11 12	10 11 *12			*13				*13	
1.2.7		*14									
1.5.1				*16	*15				*16	*17	
1.5.3				*18		*19	*19		*18		
1.7.2				*21	*20				*21	*22	
1.11 and 1.12	*27			*25	23 24						*26

LEGEND: *: Suggested teaching/learning strategy
Nos. 1-27: Activity numbers

CONTENT	TERMINAL OBJECTIVE: 1.1	LEARNING ACTIVITIES
The phenomena that occur in nature are not restricted to relationships between two living things. Many people are unaware of the effect of nonliving things on living things and of the ways in which living things modify nonliving things.		In keeping with the philosophy of the program, pupils should be encouraged from the start to understand phenomena and how they interrelate with the broader environment. The observation activities are designed to help pupils become aware of the relationships and to record them, without necessarily trying to understand them in detail. The teacher should help pupils develop a pattern of conceptual thinking that will enable them to perceive the essential characteristics of phenomena. This way of thinking should allow pupils to make generalizations; it should encourage spontaneous and original behaviour. The teacher should help pupils to observe the general characteristics of phenomena, to discover their properties, and to understand the true nature of these properties. However, it is more important to have pupils understand the interactions or links between these elements than acquire factual information about the elements themselves. It should be kept in mind that some pupils may not be very skilled at writing reports. The teacher should help them to develop skills in this area. The ability to describe phenomena is not an easy skill to master. It should be noted that nonliving phenomena per se are not emphasized in this course.

CONTENT	TERMINAL OBJECTIVE: 1.1	LEARNING ACTIVITIES
		Example 1: MOTIVATION ACTIVITY FOR OBJECTIVES 1.1.1 - 1.1.4 **TOPIC:** Phenomena **Focus of Learning:** Types of relationships. **Skills:** To know how to record characteristics. **Time:** 10 - 15 minutes. **Materials:** Slides, posters, or photographs of various phenomena. **Teaching Strategy:** Guided Class Discussion, see Section 1.3.3(e). **Procedure:** Show the slides or posters. Initiate a discussion: What is a phenomenon? What causes phenomena? N.B. See Sections 1.2.2(c) and (j) and 1.3.2. **Example 2:** ACQUISITION ACTIVITY FOR OBJECTIVES 1.1.1 - 1.1.4 **TOPIC:** Phenomena **Focus of Learning:** Types of relationships. **Skills:** To know how to record characteristics. **Time:** 30 minutes.

CONTENT	TERMINAL OBJECTIVE: 1.1	LEARNING ACTIVITIES
	Place:	Schoolyard, park, forest, meadow.
	Materials:	Pad and pencil, magnifying glass, appropriate clothing.
	Teaching Strategy:	Field Investigation, see Section 1.3.3(a).
	Procedure:	Have pupils form pairs.
		Take them to the area selected.
		Have them look for the forms and functions of different types of relationships. E.g. Ants are digging passages in the cracks in the ashphalt or concrete: this is a phenomenon of a living/nonliving relationship.
		Later on, this phenomenon will be called "burrowing" (1.7.1). Pupils should note details regarding the phenomenon itself, rather than concern themselves with zoological details about the ants.
	Questions:	Phenomena do not all follow the same pattern. Explain why this is so.
		N.B. See Sections 1.2.2 (c) and (j) and 1.3.2.

CONTENT	TERMINAL OBJECTIVE: 1.1	LEARNING ACTIVITIES
		Example 3: PERFORMANCE ACTIVITY FOR OBJECTIVES 1.1.1 - 1.1.4 TOPIC: Phenomena Focus of Learning: Relationships. Skills: To know how to record characteristics. Time: As required. Materials: Pictures (workbook or printed), photographs. Teaching Strategy: Worksheet Activity, see Section 1.3.3(f). Procedure: Show pupils pictures (see worksheet) of several different phenomena. Ask them to identify the relationships. Ask them to define the word "phenomenon." N.B. See Section 1.3.2.

CONTENT	TERMINAL OBJECTIVE: 1.1	LEARNING ACTIVITIES

WORKSHEET

Identify the types of relationships (living/living, nonliving/living, living/nonliving) shown in the pictures below.

Evaluation:

Evaluation should focus on pupils' ability to distinguish different types of relationships: living/living, nonliving/living, living/nonliving. It is very important that pupils be able to identify phenomena in pictures and to associate images with facts.

CONTENT	TERMINAL OBJECTIVES: 1.2 - 1.4	LEARNING ACTIVITIES

Nonliving things have characteristics that are different from those of living things. They also have properties that are both measurable and variable. For example, temperature is a property of matter; when the temperature varies, it brings about changes in the nature of matter. It is therefore difficult to dissociate this property, which is verifiable in air, water, and soil, from the element it modifies.

A nonliving thing can affect another nonliving thing, causing various phenomena which, sooner or later, will have an effect on living things.

In this introductory investigation activity, pupils should begin to handle instruments. They should take different measurements and, from these, draw some partial conclusions. This process involves a degree of trial and error. The notion of "measurable property" implies the need to use the mathematical concepts of order and equivalence in the acquisition activities.

It is normal at the beginning of the school year to give pupils an activity involving manipulations, either one that follows a specific procedure or one which includes questions for reflection. In terms of instruments, it is not recommended that analysis "kits" be used, as they often require an understanding of concepts that are beyond the scope of Secondary I pupils. It is important, however, to have a sufficient number of instruments that are easy to use.

Very little time is devoted to phenomena involving nonliving things, because these will be studied in geography. However, the characteristics of certain elements are covered here. Pupils investigate the properties of soil because of its importance in life cycles, of air because of its effect on all organisms, and of pollutants because of their harmful effect on the physical environment.

Example 4: MOTIVATION ACTIVITY FOR OBJECTIVES 1.2.1 - 1.2.4

TOPIC: Measuring Nonliving Things

Focus of Learning: The properties of nonliving things.

Time: 10 - 15 minutes.

CONTENT	TERMINAL OBJECTIVE; 1.2	LEARNING ACTIVITIES
	Materials:	Thermometer, anemometer, photometer, etc., slides showing a meteorological station.
	Teaching Strategy:	Guided Class Discussion, see Section 1.3.3(e).
	Procedure:	Set up the measuring instruments so that pupils can look them over.
		Pass them around the teams of pupils.
		Show the slides of a weather station.
		Initiate an open discussion. N.B. See Sections 1.2.2(d) and 1.3.2.
	Example 5:	ACQUISITION ACTIVITY FOR OBJECTIVES 1.2.1 - 1.2.4
		TOPIC: Measuring Nonliving Things.
	Focus of Learning:	The properties of nonliving things.
	Skills:	To know how to take a measurement. To know how to take a precise reading on an instrument.
	Time:	30 - 45 minutes.
	Place:	Schoolyard or elsewhere.
	Materials:	Thermometer, anemometer, etc.
	Teaching Strategy:	Field Investigation, see Section 1.3.3(a).
	Procedure:	Have pupils handle the instruments in the classroom or outside.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES
		Have pupils draw a simple sketch of the instruments. Have them describe briefly the functions of the instruments. N.B. See Sections 1.3.4(e) and (g) and 1.2.2(b) and (j). **Questions:** What is the purpose of a measuring instrument? What property does a given measuring instrument measure? **Example 6:** ACQUISITION ACTIVITY FOR OBJECTIVES 1.2.1 - 1.2.3 **TOPIC: Measuring Nonliving Things.** **Focus of Learning:** The properties of nonliving things. **Skills:** To know how to take a precise reading on an instrument. To know how to construct a histogram. **Time:** 10 minutes a day for 4 - 5 days. **Place:** Different places around the school or home. **Materials:** Thermometer, anemometer, photometer, etc., squared paper (6 x 6 mm). (Later on pupils will use graph paper.)

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES
		Teaching Strategy: Field Investigation, see Section 1.3.3(a). **Procedure:** Each day at the same time, have pupils measure: . air temperature, . wind speed, . light intensity. Have pupils transpose this data to a histogram (have ready a short explanation of how to construct a histogram). N.B. See Section 1.2.2(c). **Questions:** Why is it necessary to take measurements over a period of several days? Why is this done at the same time each day? What are we trying to find out in this experiment? Etc. **Example 7:** PERFORMANCE ACTIVITY FOR OBJECTIVES 1.2.1 - 1.2.4 **TOPIC: Measuring Nonliving Things** **Focus of Learning:** The properties of nonliving things. **Skills:** To know how to take a precise measurement on an instrument. To know how to follow a procedure. **Time:** 45 minutes.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES
	Place:	A forest and a field, or an urban park and a neighbourhood street.
	Materials:	Sufficient number and variety of instruments, worksheet, pad and pencil.
	Teaching Strategy:	Field Investigation, see Section 1.3.3(a).
	Procedure:	Take pupils out on a field trip. Give each pupil a worksheet. Have pupils work in teams. Follow the worksheet procedure. N.B. See Section 1.2.2 (a) and (j).

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES

1. Air temperature — Use a mercury thermometer.
   Outside the forest: ___ °C — Conclusion ___
   In the forest: ___ °C ___

2. Soil temperature — Use a metal thermometer.
   Outside the forest: ___ °C — Conclusion ___
   In the forest: ___ °C ___

3. Light intensity — Use a photometer.
   Outside the forest: ___ units — Conclusion ___
   In the forest: ___ units ___

4. Relative humidity — Use a hygrometer.
   Outside the forest: ___ % — Conclusion ___
   In the forest: ___ % ___

5. Wind velocity — Use an anemometer.
   Outside the forest: ___ km/h — Conclusion ___
   In the forest: ___ km/h ___

Evaluation:

Pupils should know some of the properties of nonliving things. They should also know how to take precise readings on an instrument and to record them.
If pupils do not get very good results, it probably means that they did not use the instruments correctly.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES

Example 8: PERFORMANCE ACTIVITY FOR OBJECTIVE 1.2.1

TOPIC: Nonliving Things

Focus of Learning: The properties of air.

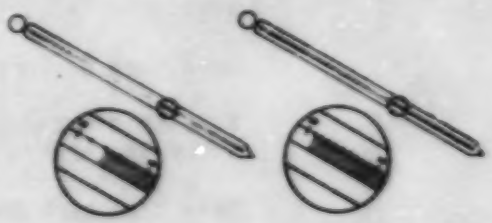
Skills: To know how to take a precise reading on an instrument.

Time: As required.

Materials: Worksheets or transparencies which contain a variety of problems.

Teaching Strategies: Oral Presentation and Worksheet Activity, see Section 1.3.3(f) and (j).

Procedure: Review with pupils a previous acquisition activity.



E.g. During the field trip, you measured the temperature of the surrounding air in different locations. These drawings show two of the results obtained.

Have pupils complete a number of worksheets.

Questions:

- What conclusions can be drawn?
- Why is the air temperature not the same everywhere?

N.B. These questions can be reformulated to be more specific.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES
		Evaluation: Evaluation should cover the characteristics of nonliving substances. It should be noted that the second problem calls upon the pupils' ability to take measurements. If pupils do not achieve very good results, it is probably because they did not use the instruments correctly.
		Example 9: MOTIVATION ACTIVITY FOR OBJECTIVES 1.2.5 - 1.2.6
		TOPIC: Nonliving Things
		Focus of Learning: The properties of nonliving things.
		Time: Two steps of 10 minutes each.
		Materials: Petri dishes, balance, drying oven, materials for burning, a fruit or a vegetable.
		Teaching Strategy: Laboratory Investigation, see Section (b).
		Procedure: Have pupils determine the mass of the fruit or vegetable (e.g. tomato). Have them dehydrate the tomato. Have them determine the mass of the dried tomato. . Why is there a difference in mass? Have them burn the dried sample. Have them determine the mass of the sample again. . Why is there a difference in mass? . Why do the ashes not burn? . Is it possible to establish a connection between this tomato and soil? . Etc.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES

Example 10: ACQUISITION ACTIVITY FOR OBJECTIVES 1.2.4 - 1.2.5

TOPIC: Nonliving Things

Focus of learning: Presence of water in soil.

Skills: To know how to take a precise reading on an instrument.
To know how to follow a procedure.

Time: 3 steps: preparation 10 - 15 minutes,
drying 60 - 90 minutes,
completion 10 - 15 minutes.

Materials: Pyrex petri dishes, balance, drying oven, soil samples.

Teaching Strategies: Laboratory Investigation or Demonstration, see Section 1.3.3(b) and (c).

Procedure: Before starting the activity, fresh soil samples should be obtained.

Have pupils form teams.
(This activity can be combined with another one.)

Make sure pupils identify the petri dishes clearly.

A 40°C temperature should be maintained throughout the investigation.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES

WORKSHEET

Percentage of Water in the Soil

Procedure:

1. Label your petri dish with your name and the experiment number.
2. Determine the mass of the petri dish.
3. Pour a small quantity of soil into the dish.
4. Determine the mass of the soil in the dish (do not forget to subtract the mass of the dish). This soil sample is called "wet soil."
5. Dry the soil sample in the oven.
6. Follow the operating instructions for the oven.
7. When the sample is dry, determine its mass again. This soil sample is called "dry soil."
8. Calculate, as follows:

Wet soil: ..... g
Dry soil: - ..... g
Quantity of water: ..... g
Percentage of water in the soil=

$$\frac{\text{(Quantity of water)}\ldots\ldots \times 100}{\text{Wet soil}\ldots\ldots} = \ldots\ldots\%$$

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES

Questions:

- Why would a soil sample be dried to find the quantity of water it contains?
- Which of the properties of soil were touched on in this activity?
- Etc.

Example 11: ACQUISITION ACTIVITY FOR OBJECTIVES 1.2.4 AND 1.2.6

TOPIC: Nonliving Things

Focus of Learning: Presence of organic matter in soil.

Skills: To know how to take a precise measurement on an instrument.
To know how to follow a protocol.

Time: 30 - 45 minutes.

Materials: Pyrex petri dishes, balance, materials needed for burning: a porcelain or metal crucible, propane torch or small incinerator, heatproof mitts, etc.
Sample of dry soil.

Teaching Strategies: Laboratory Investigation or Demonstration.

Procedure: Use the procedure followed in Example 10.

Use the dried soil sample from Example 10 or one of the other previously dried samples.

Determine the mass of the sample.

Burn the sample.

Determine the mass of the sample again.
N.B. The nonliving part does not burn.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES
		Questions: . Why is a dried soil sample used to determine the quantity of organic matter in soil? . Which of the properties of soil were touched on in this activity? . Etc.
		Example 12: ACQUISITION ACTIVITY FOR OBJECTIVES 1.2.4 AND 1.2.5
		TOPIC: Nonliving Things
		Focus of Learning: The water-retention capacity of soil.
		Skills: To know how to take a precise measurement. To know how to follow a procedure.
		Time: 15 - 20 minutes.
		Materials: Erlenmeyer flasks or beakers (2), funnels (2), filter paper, graduated cylinder (100 cc), soil samples (sand, earth, etc.).
		Teaching Strategies: Laboratory Investigation or Demonstration.
		Procedure: Set up the equipment (see sketch). Place the filter paper in the funnels. Pour an equal quantity of soil into each funnel. Fill the graduated cylinder with a given quantity of water (e.g. 100 ml).

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES

Pour the same quantity of water into each funnel. After 5 minutes, have them measure the amount of water that has collected in the erlenmeyer flasks.

Record the results.
N.B. The soil samples should be dried before the investigation is started.

Questions:

- What would you think is the main quality of soil which retains a large quantity of water?
- Do you know what farmers think of this type of soil?

Example 13: PERFORMANCE ACTIVITY FOR OBJECTIVE 1.2.5

TOPIC: Nonliving Things

Focus of Learning: The properties of soil.

Skills: To know how to take a precise reading.
To know how to follow a procedure.

Time: As required.

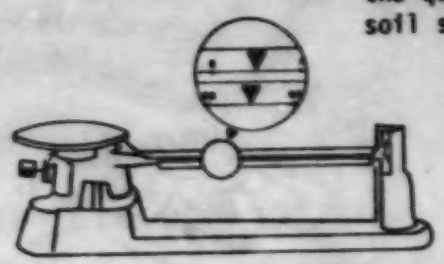
Materials: Worksheets or transparencies which contain a variety of problems.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES

Teaching Strategies: Oral Presentation and Worksheet Activity.

Procedure: Review with pupils a previous acquisition activity.

E.g. In the laboratory activity, you determined the quantity of water retained in a given soil sample, following this procedure:



- The mass of the wet soil sample was 30 g.
- After drying the sample, you measured it again.
  The drawing shows the result.

Determine the percentage of water in the sample:

Wet soil ..... g
Dried soil ..... g
Quantity of water ..... g

$$\frac{\text{Quantity of water}}{\text{Wet soil}} \text{ ..... x } 100 = \text{.....}\%$$

Have pupils complete several worksheets.

Questions:

- What conclusions can be drawn?
- Does this soil sample come from land that is good for cultivation?
  Why?
- Etc.

N.B. These questions can be reformulated to be more specific.

CONTENT	TERMINAL OBJECTIVE: 1.2	LEARNING ACTIVITIES
	Evaluation:	Evaluation should cover the characteristics of nonliving substances. Pupils should know that soil has properties that can be measured. It should be noted that the second problem calls upon pupils' ability to take measurements. If pupils do not achieve very good results, it is probably because they did not use the instruments correctly.
	Example 14: ACQUISITION ACTIVITY FOR OBJECTIVE 1.2.7	
		TOPIC: Nonliving Things
	Focus of Learning:	The presence of air in soil.
	Skills:	To know how to take an accurate reading. To know how to follow a procedure.
	Time:	20 - 30 minutes.
	Materials:	100 cc graduated cylinders (2), soil samples (sand, earth, etc.).
	Teaching Strategy:	Laboratory Investigation.
	Procedure:	Pupils should use the procedure followed in Example 10. They pour the soil sample into the graduated cylinder (e.g. up to 50 ml). Using a second graduated cylinder, they pour water into the soil sample until the soil is saturated. N.B. The water replaces the air.
	Questions:	. Which of the properties of soil were touched on in this activity?

CONTENT	TERMINAL OBJECTIVE: 1.5 - 1.10	LEARNING ACTIVITIES
The best-known phenomena are those pertaining to relationships among living things. However, these phenomena are not readily observable. The same can be said for nonliving/living and living/nonliving phenomena. Observation and deduction has enabled man to construct a reasonably accurate picture of the patterns of many phenomena, to give them names, and to know when they occur. Phenomena involving humans are also important. A major one is pollution, which is examined here as a contaminator of both the external environment (air, water, soil) and the internal environment (physical and mental health).		Teachers should make sure that a variety of reference material is available to pupils when they are doing research activities. Some materials might appear to be difficult to use, but if the teacher gives good references (titles, page numbers), pupils should have little difficulty in finding the necessary information. Audiovisual materials should also be used as reference material. The ability to consult reference material is an important skill to develop. Emphasis here is on having pupils know how to choose the passage in a book that best answers a specific question. It is not necessary for pupils to find precise definitions, they should look for possible causes and effects. In preparing an activity in which pupils will need to consult reference material, the teacher must have appropriate scientific material available. This type of activity is most effective when it leads pupils to ask questions such as "What is the link between...?" or "What form does this phenomenon take?" As pupils begin to be able to identify different phenomena, they will become more aware of what goes on around them. Learning the names of phenomena motivates pupils to learn more and makes it possible for them to develop more coherent and structured thinking, and to expand their scientific vocabulary. Pupils will be introduced gradually to less common phenomena, and in this way they will further develop their understanding of the complexity of the relationships in the natural world.

CONTENT	TERMINAL OBJECTIVE: 1.5	LEARNING ACTIVITIES

A distinction is made here between living/nonliving relationships and nonliving/living relationships. In the former situation, the living things do not undergo any significant changes. They remain active, they respond, and they benefit from the situation. In the latter situation, the living thing is subjected to the action of a nonliving thing. It does not, however, totally succumb in the process, even if the nonliving thing represents an irresistible force. Further on it will be seen how it adapts.

Example:
When a beaver builds a dam, it uses the water for its own purposes; this phenomenon, however, will be viewed separately from that of the deterioration which the beaver causes in the environment. The spider, in spinning its web, uses the air (nonliving

Example 15: MOTIVATION ACTIVITY FOR OBJECTIVE 1.5.1

TOPIC: An Almost Insatiable Hunger

Focus of Learning: The concept of predation.

Skill: To know how to select the passage in a reference book which answers a specific question.

Time: 15 - 20 minutes.

Materials: Films, photographs, pictures illustrating predation

Teaching Strategy: Guided Class Discussion, see Section 1.3.3(e).

Procedure: Show pupils the films and pictures and point out such things as: stalking, doubling (of quarry), attacking, mimicry of prey, flight, predators' need for food.

Recount stories about predation seen in nature, on television, etc.

Give pupils problems involving the theory of sets: "What would A do when he met B if he was stronger than B?

CONTENT	TERMINAL OBJECTIVE: 1.5	LEARNING ACTIVITIES
element) for its own purpose; this phenomenon will also be viewed separately from that of predation, which is the primary purpose of the web.	Example 16: ACQUISITION ACTIVITY FOR OBJECTIVE 1.5.1 TOPIC: An Almost Insatiable Hunger Focus of Learning: The concept of predation. Skill: To know how to select the passage in a reference book which answers a specific question. Time: 1 class period (or can be given as homework). Materials: Variety of books, magazines. Teaching Strategies: Research and Written or Oral Report, see Section 1.3.3(d) and (i). Procedure: Define such words as: predator, prey, hunt, attack, stalk. Have pupils research the following topic: "The sequence of steps followed by the predator of a given animal species in capturing its prey." Ask pupils to give a presentation, with pictures, on what they have discovered, using posters, transparencies, and so on. Questions: . In a situation involving predation, if A meets B, does A always get what it seeks? . Is it possible that B will survive and that it was designed to be more than simply a prey for A?	

CONTENT	TERMINAL OBJECTIVE: 1.5	LEARNING ACTIVITIES
		. Have you learned to distinguish different stages in the act of predation? . Have you consulted a variety of reference material?
		Example 17: PERFORMANCE ACTIVITY FOR OBJECTIVE 1.5.1
		TOPIC: An Almost Insatiable Hunger
		Focus of Learning: The concept of predation.
		Skill: To know how to select the passage in a reference book which answers a specific question.
		Time: 30 - 50 minutes.
		Materials: Passage from a book and/or a short film or audio-visual presentation with a commentary on the subject.
		Teaching Strategy: Worksheet Activity, see Section 1.3.3(j).
		Procedure: Give pupils a special worksheet which includes a description of facts related to predation. Add definitions of the most difficult words. Include one or more questions on the topic.

CONTENT	TERMINAL OBJECTIVES: 1.5 - 1.10	LEARNING ACTIVITIES

WORKSHEET

The following is an excerpt from Marcel Roland's, "Vie et mort des insectes" from the journal Le Jeune Naturaliste, 5th year, No. 9, May 1955.

Read the excerpt first and then look for the passages that contain(s) the answer to each problem.

The Praying Mantis, a Carnivorous Insect

When the female praying mantis wishes to replenish her larder, she lets her chosen victim approach and then, in a flash, she thrusts forward her two raptorial front legs...

The physical build of our heroine, her **anatomy**, dictates her life. Her hunger is virtually insatiable and, to meet this need, she has a perfect set of tools: piercing mouthparts, pincer-like jaws and a chewing mechanism which makes the human mouth, with its two rows of teeth, seem woefully inadequate!

If you look at the mantis' mouth through a magnifying glass, you will see a masterpiece of ingenuity, refinement, and precision. A **labrum**, two incisive **mandibles**, two palps, and a four-pointed tongue which, fitted into a tiny space, all work together to grind and chop up the prey. A fly or a grasshopper enters into this clockwork movement and comes out in a form of a purée fine enough to pass through an **esophagus** with a diameter the size of a pin!

CONTENT	TERMINAL OBJECTIVES: 1.5 - 1.10	LEARNING ACTIVITIES

And to complement these physical attributes, the mantis is clever and patient: it brings to mind the way cats crouch when they stalk their pray. The mantis waits for hours without moving, sometimes resting on its stomach, seemingly meditating in a dignified fashion, sometimes attached to a twig by its hind legs, but always immobile. This immobility is essential, for it reassures nearby or passing insects who, unaware, venture too close and are seized in its fatal vice-like grip.*

anatomy: study of the forms and structures of living things
labrum: upper part of the mouth
mandibles: jaws
esophagus: passage which runs from the mouth to the stomach

* The above citation is a free translation.

Question: Give the sequence of steps in a praying mantis' attack.

Evaluation: Pupils should be able to recall certain information, such as the fact that predation involves both a predator and a prey, and that in spite of the seeming cruelty, predation is essential to the survival of most living things.

Pupils should also be able to summarize a passage in a few words. While this skill may seem difficult at first, it is a necessity if pupils are to be able to consult reference material efficiently. Pupils should not be expected to have mastered this skill after one simple exercise.

CONTENT	TERMINAL OBJECTIVES: 1.5 - 1.10	LEARNING ACTIVITIES

Example 18: ACQUISITION ACTIVITY FOR OBJECTIVE 1.5.3

TOPIC: **A Living Thing Which Lives at the Expense of Others**

Focus of Learning:	The concept of parasitism.
Skill:	To know how to select the passage in a reference book which answers a specific question.
Time:	1 class period (the work can be completed outside of class).
Materials:	Various books and journals.
Teaching Strategies:	Research and Written or Oral Report.
Procedure:	Explain the words or expressions--host, parasite, external parasite, internal parasite. Have pupils research: "How a parasite attaches itself to its host." Ask pupils to give an illustrated presentation on what they have discovered, using posters, transparencies, and so on.
Questions:	. In a situation involving parasitism, when A meets B, does A always get what it seeks?

CONTENT	TERMINAL OBJECTIVES: 1.5 - 1.10	LEARNING ACTIVITIES
		. Does the host become a victim whether it wants to or not? . Have you consulted a variety of reference material? . Do you know more about parasites and their role in nature than you knew before? . Etc.
		Example 19: ACQUISITION ACTIVITY FOR OBJECTIVE 1.5.3
		TOPIC: A Living Thing Which Lives at the Expense of Others
		Focus of Learning: The concept of parasitism.
		Skill: To know how to select the passage in a reference book which answers a specific question.
		Time: As required.
		Materials: Passage from a book and/or a short film, or an audiovisual presentation with a commentary on the subject.
		Teaching Strategies: Oral or Audiovisual Presentation. See Section 1.3.3 (f) and (g).
		Procedure: Give pupils a special worksheet which includes a number of passages describing facts related to parasitism. Add definitions of the most difficult words. Include one or more questions.

CONTENT	TERMINAL OBJECTIVES: 1-5 - 10	LEARNING ACTIVITIES

WORKSHEET

The following article by Adrien Robert, C.S.V., is taken from the journal Le Jeune Naturaliste, 5th year, No. 9, May 1955.

Read the excerpt first and then look for the passage(s) which contain(s) the answer to each question.

Dutch Elm Disease

(1) This year, once again, elms can be seen that will never become green again, elms that will keep their winter look all summer long. For a year or more, the sap has not run in their vessels. They have become infected with Dutch elm disease. They still maintain their fan-shaped structure and their trunks are still healthy, but their branches can no longer receive the elements from the soil which they need to produce leaves.

(2) Their fate is sealed: they are dead in spite of the small bunch of foliage growing from the trunk or a root. Many of the branches are dried out and riddled with insect larvae. The bark has already begun to come away from the wood. Soon, the smaller branches will fall to the ground because, as they become weakened by insects boring into them and then exposed to the humidity and frosts of winter, they will become rotten and break off.

(3) The disease is caused by fungus spores which spread very quickly once they are introduced into the channels under the bark of the elm. When the spores have spread throughout the tree, they begin to form thin white filaments which grow very rapidly, fed by the sap which provides all they need to grow.

CONTENT	TERMINAL OBJECTIVES: 1.5 - 1.10	LEARNING ACTIVITIES
		(4)A large quantity of filaments block the vessels; the sap stops running because it can no longer circulate. The vessels deteriorate. The leaves do not receive the sap they need and so they wilt and drop early. (5)From the time the fungus spores enter the bark, it can take as little as twenty days for the disease to become visible to an observer. One of the first signs of the presence of the disease is the premature yellowing of many of the leaves, which soon die and are blown away by the wind. Sometimes only a few branches are affected; other times the disease spreads throughout the whole tree. Two weeks after the disease appears, 50% to 80% of the leaves have already fallen to the ground. (6)Studies done in Europe, in the United States, and in the province of Québec have shown that insects carry the spore from diseased elms to healthy ones. The spread of the disease is not intentional on the part of the insects; it is purely by chance that they carry the spores from tree to tree. (7)The disease is spread by the European elm bark beetle. It has been laying its eggs in infected trees ever since the disease first came to the province. When the young adult beetles emerge through the bark, the fungus sticks to the fine close hair on their bodies and is carried away. (8)The beetles then go to other elms to feed. They bore through the bark and into the wood.* *The above citation is a free translation.

CONTENT	TERMINAL OBJECTIVES: 1.5 - 1.10	LEARNING ACTIVITIES
		Questions: . How is Dutch elm disease transmitted or carried? . Etc.
		Evaluation: Pupils should be able to recall certain information, such as the fact that parasitism involves a parasite and a host. This phenomenon may seem unjust, but it is an essential feature of the living world. If they are to survive, living things must live in relation to, and sometimes at the expense of other living things. Pupils should also be able to find the passage(s) in a book which give(s) the specific answer to a given question.
		Example 20: MOTIVATION ACTIVITY FOR OBJECTIVE 1.7.2 **TOPIC: Animals Are Ingenious Creatures** **Focus of Learning:** Relationships between living and nonliving things. **Time:** 5 - 10 minutes. **Materials:** Photographs of spiders in their webs, photographs or specimens of bird nests, etc. **Teaching Strategy:** Guided Class Discussion.

CONTENT	TERMINAL OBJECTIVE: 1.7	LEARNING ACTIVITIES
		Procedure: Show pictures or specimens of spiders. Initiate a discussion: . Is a spider an insect? . Why are most people afraid of spiders? . Could you make a spider's web? Show pictures or specimens of bird nests. Initiate a discussion: . What is the purpose of a nest? . Do all birds build nests? . Etc. **Example 21:** ACQUISITION ACTIVITY FOR OBJECTIVE 1.7.2 **TOPIC: Animals Are Ingenious Creatures** **Focus of Learning:** Relationships between living and nonliving things. **Skill:** To know how to select the passage in a reference book which answers a specific question. **Time:** As required. **Materials:** Reference books, government publications, poster paper. **Teaching Strategies:** Research and Written or Oral Report.

CONTENT	TERMINAL OBJECTIVE: 1.7	LEARNING ACTIVITIES
	Procedure:	Suggest a variety of topics: . beaver dam . spider web . bird nest . beehive . etc. Ask pupils to look for information which describes the preparatory steps involved in the construction of these homes. Ask pupils to show what they have discovered. They could, for example, reproduce a scale model of a beaver dam or use string to make a spider web, etc.
	Questions:	. Have you learned the different steps in a given construction? . Does an animal take any precautions before it starts to build? . Have you consulted a variety of reference material? . Etc.
	Example 22: PERFORMANCE ACTIVITY FOR OBJECTIVE 1.7.2	
		TOPIC: The Genius of the Spider
	Focus of Learning:	Relationships between living and nonliving things.
	Skill:	To know how to select the passage in a reference book which answers a specific question.

CONTENT	TERMINAL OBJECTIVE: 1.7	LEARNING ACTIVITIES

Time: 30 minutes.

Materials: Worksheet illustrating the sequence of steps in the construction of a spider web.

Teaching Strategy: Worksheet Activity, see Section 1.3.3(j).

Procedure: Make up a worksheet for pupils with a series of pictures or drawings of the 12 steps involved in the construction of a circular spider web, with a description of each step.

WORKSHEET

Circular webs are usually spun at night. First, a bridge is stretched between two anchor points. The spider can walk from one anchor to the next carrying the thread, but normally it tilts its abdomen in such a way that the thread is drawn out and carried by air currents (1). If the tread makes contact, an anchor point is formed (2); if not, the thread is brought back and eaten.

Once the bridge is made, the spider runs back and forth, adding more spider silk to reinforce it. The spider then descends vertically on a thread (3), which it has first anchored at the centre of the bridge, down to one of the bridge's foundation lines. It anchors this vertical thread and returns to the fork, which is to form the centre of the web (4).

Next, a radial thread attached to the centre is taken to the first point, then carried a short distance on the outer perimeter (5) and back to the centre (6). The other spokes of the web are formed in the

CONTENT	TERMINAL OBJECTIVE: 1.7	LEARNING ACTIVITIES

WORKSHEET

same way (7-9). When the spokes are completed, the centre is reinforced with additional threads before the spider starts making a temporary spiral (10). When the spider has gone around once, it touches the thread with one leg to measure the distance between the spirals as it makes them. After completing the temporary spiral, the spider changes direction, gathers up its thread and replaces it with a new sticky thread, making a more closely knit spiral than before (11). It then proceeds to work its way back to the centre of the web (12).

Normally, within a few days, the sticky thread begins to dry out or break, at which time it is removed and replaced. A decorative weave, characteristic of the species, is sometimes added at the centre.

Sometimes, the spider builds a silk hide-out under a cover of leaves on one side of its web; a thread running from this to the centre of the web vibrates whenever an insect is caught in the lethal trap. The formation of other types of webs involves greater detail and variations.

Questions:

- How does the spider manage to attach the first length of thread?
- How does the spider strengthen its web?
- How does the spider know when something is caught in its web?
- Etc.

CONTENT	TERMINAL OBJECTIVE: 1.7	LEARNING ACTIVITIES

Try to find the picture that corresponds to each of the numbered phrases in the passage.

CONTENT	TERMINAL OBJECTIVES: 1.11 - 1.12	LEARNING ACTIVITIES

Perhaps through habit or ignorance, man generally places too little importance on his relationship with nature. Every day, he uses water, air, soil, fauna and flora to satisfy his needs. His way of life is closely linked to the exploitation of resources; he justifies all of his actions by claiming that they contribute to the common good.

This perception is faulty, for the exploitation of resources should be regarded as a privilege that society must once again learn to appreciate. To this end, the different ways in which resources are used should be reexamined so that their advantages and disadvantages may be identified. Nature is not a museum made up of separate, static elements. It is a system made up of elements that interact constantly with one another.

Activities introduced in this sequence, which focuses on communication, should serve to stimulate ideas and encourage discussion. These could involve recreating an interesting situation based on real life. The discussion or dialogue should focus on an example that is characteristic of a region known to the pupils. It is important to note that a dialogue should address a specific problem which requires a solution.

The tables below provide an overview of the topics covered in Objectives 1.11 and 1.12. They are not intended to be used as lesson plans.

Example 23: MOTIVATION ACTIVITY FOR OBJECTIVES 1.11 and 1.12

TOPIC: Use of Resources

Focus of Learning:	Activities that are essential to man's way of life.
Skill:	To know how to solve a problem related to a given situation.
Time:	15 minutes.
Materials:	Photographs.
Teaching Strategy:	Guided Class Discussion.
Procedure:	Help pupils formulate a problem based on the photographs. Have pupils investigate both the positive and negative aspects (the advantages and disadvantages).

CONTENT	TERMINAL OBJECTIVES: 1.11 - 1.12	LEARNING ACTIVITIES
One of the underlying social premises of this course is the belief that the nature of man has not changed, rather, it is his way of life that has evolved. Once a nomad, man became a sedentary being. He learned to master fauna, flora, and raw materials, which in turn enabled him to proliferate to the extent that he could significantly alter his natural environment.		Help them try to identify the causes of the disadvantages with a view to finding ways to overcome them. E.g. Photograph(s) illustrating a water fountain clogged with paper. Positive aspects: satisfies thirst, etc. Negative aspects: wastes water, etc. Solutions: investigate preventive measures (discreet warnings). **Example 24:** MOTIVATION ACTIVITY FOR OBJECTIVES 1.11 AND 1.12 **TOPIC: Use of Resources** **Focus of Learning:** Activities that are essential to man's way of life. **Skill:** To know how to solve a given problem. **Time:** Unspecified. **Materials:** An audiovisual presentation or film depicting an example of environmental deterioration. Slides illustrating conflict of interest, i.e. the positive and negative aspects of the pupils' environment. **Teaching Strategy:** Guided Class Discussion. **Procedure:** Projection of audiovisual material.

CONTENT	TERMINAL OBJECTIVES: 1.11 - 1.12	LEARNING ACTIVITIES
		E.g. Photographs of a polluted river, an overflowing trash can, a clogged water fountain, etc. Discussion: . What causes these situations? . What is pollution, wastage? . Etc. N.B. It is preferable to avoid influencing the pupils' thinking. Their ideas and opinions should be respected, see Section 1.2.2(f). **Questions:** . To what extent are activities such as agriculture and forestry essential to man? . Has man always exploited the resources of the environment as he is doing today? . What is a resource? **Example 25:** ACQUISITION ACTIVITY FOR OBJECTIVES 1.11 AND 1.12 **TOPIC: Use of Resources** **Focus of Learning:** Activities that are essential to man's way of life. **Skill:** To know how to solve a problem related to a structure. **Time:** Unspecified.

CONTENT	TERMINAL OBJECTIVES: 1.11 - 1.12	LEARNING ACTIVITIES

Materials: Table(s) to be filled in (see following diagram).

Type of Use	Advantages	Disadvantages	Solutions
Agriculture			

Teaching Strategy: Research, see Section 1.3.3(d).

Procedure:

Divide the class into three groups representing the basic resources used by man: water, air and land.

Have pupils form pairs.

Ask the pairs to identify some ways in which man uses resources and to indicate the advantages and disadvantages.

Ask the pairs to find ways to overcome the disadvantages.

Have them use the suggested tables to compile their information (see the following pages).

Questions:

. Can it be said that the population is generally well informed about the different uses made of environmental resources?

Principal Uses of Resources by Man		
USE OF LAND (terrestrial environment)	USE OF WATER (aquatic environment)	USE OF AIR (atmospheric environment)
Agriculture	Energy	Energy
Forestry	Fisheries	Transportation
Urban development a) housing b) industry c) green spaces d) waste disposal	Transportation	Waste Disposal
	Waste Disposal	Communication
	Aqueducts	Chemical Industries
Mines	Chemical Industries	
Parks and Reserves		
Recreation	Recreation	Recreation

USE OF LAND			
TYPE OF USE	ADVANTAGES	DISADVANTAGES	POSSIBLE SOLUTIONS OR ALTERNATIVES
AGRICULTURE	Food for man and livestock	Impoverishment of the soil	Crop rotation Use of fertilizers Biological and chemical control Soil conservation techniques
FORESTRY	Housing Paper Furniture Heating	Erosion Forest degeneration Gradual elimination of fauna Elimination of particular species of flora	Appropriate clearing methods (patch method, selective cutting, strip cutting) Reforestation Controlled use Recycling of paper (fibres)
URBANIZATION A) HOUSING	Rational plan for residential development	Air pollution Water pollution Waste material Use of space	Zoning Public transportation Water treatment (biodegradation, recycling, purification) Green spaces

USE OF LAND			
TYPE OF USE	ADVANTAGES	DISADVANTAGES	POSSIBLE SOLUTIONS OR ALTERNATIVES
B) INDUSTRIALIZATION	Economy, transportation	Significant air, water and soil pollution Industrial waste	Pollution control systems Rational use of energy Recycling, relocation
C) GREEN SPACES	Quality of life (oxygenation, community gardens, recreation)	Open to abuse (dumping trash, damaging trees, vandalism, etc.) Impede industrial and urban development	Rational use Careful pre-planning of new green spaces Strict regulations aimed at people, who are the worst polluters Educating the public
D) WASTE DISPOSAL	Confinement of waste material to an isolated area Garbage collection services	Of particular concern in larger cities Sources of pollution of: - land - water - air	Incinerators Organic cultures Burial Treatment Fertilizers Recycling of metals, glass Use as energy source Production of hydrocarbons
MINES	Economy Energy	Non-renewable resources Poor location Various forms of pollution	Planned development and use Recovery of metals and by-products
PARKS AND RESERVES	Protection of certain species of animals and plants	Restrict use by man	Rational use Reproduction of livestock
RECREATION	Hunting Outdoor activities Excursions Camping Etc.	Deterioration of landscape Decrease in fauna and flora	Education Application of ecological principles Application of regulations

USE OF WATER			
TYPE OF USE	ADVANTAGES	DISADVANTAGES	POSSIBLE SOLUTIONS OR ALTERNATIVES
ENERGY	Low-pollution hydro-electric power Major source of O_2 (photosynthesis)	Building of dams Ecological imbalance	Rational use Conservation of all forms of energy (wind, solar, geothermic)
FISHERIES	Food for man Production of fertilizer and feed	Depletion of aquatic fauna (marine and fresh water)	Controlled use of marine and fresh water fauna
TRANSPORTATION	Facilitates inter-continental trade	Source of pollution	Rational use
WASTE DISPOSAL	Elimination of wastewaters	Source of pollution	Water treatment Recycling plants
NUTRITION (drinking water)	Essential for plants and animals	Need for water filtration plants	Rational use
RECREATION	Fishing Canoeing Etc.	Source of pollution Decrease in fauna and flora	Education Application of ecological principles Application of regulations
CHEMICAL INDUSTRIES	Easy disposal of certain wastes Cooling Sewers	Chemical and thermal pollution Diminished supply of drinking water Waste disposal	Filtration Treatment of wastewaters Recycling of certain products Closed cooling systems

USE OF AIR			
TYPE OF USE	ADVANTAGES	DISADVANTAGES	POSSIBLE SOLUTIONS OR ALTERNATIVES
ENERGY	Principle source of oxygen	Source of pollution	Reduce quantity of waste emitted into the air Rational use
TRANSPORTATION	Saves time in international transportation of goods and people	Source of pollution Noise Gas	Rational use Increase ratio of energy to goods and persons transported
WASTE DISPOSAL	Practical and convenient	Source of pollution Risk of disturbing the ecological balance	Pollution control systems Rational use Reduce use of forms of energy which produce waste material
COMMUNICATION	Speed and facility (air waves)	Overloading of air waves	Rational use
RECREATION	Travel Leisure	Source of pollution Decrease in fauna and flora	Rational use Application of ecological principles Application of regulations
CHEMICAL INDUSTRIES	Easy disposal of certain wastes	Chemical pollution Decreased quality of air	Recycling of certain products System for recovery of certain waste products System for greater combustion efficiency

CONTENT	TERMINAL OBJECTIVES: 1.11 - 1.12	LEARNING ACTIVITIES

Example 26: PERFORMANCE ACTIVITY FOR OBJECTIVES 1.11 AND 1.12

TOPIC: Use of Resources

Focus of Learning: Activities that are essential to man's way of life.

Skill: To know how to solve a problem related to a given situation.

Time: Unspecified.

Materials: Cardboard, paper, glue, paint, newspaper and magazine clippings, etc.

Teaching Strategy: Community-Based Project or Activity, see Section 1.3.3(k).

Procedure:

Divide the class into three groups representing the basic resources used by man: water, air and land.

Have pupils form teams of two or four.

Ask the teams to record the uses of a given resource, such as water, on a piece of cardboard or paper indicating the advantages and disadvantages of certain practices.

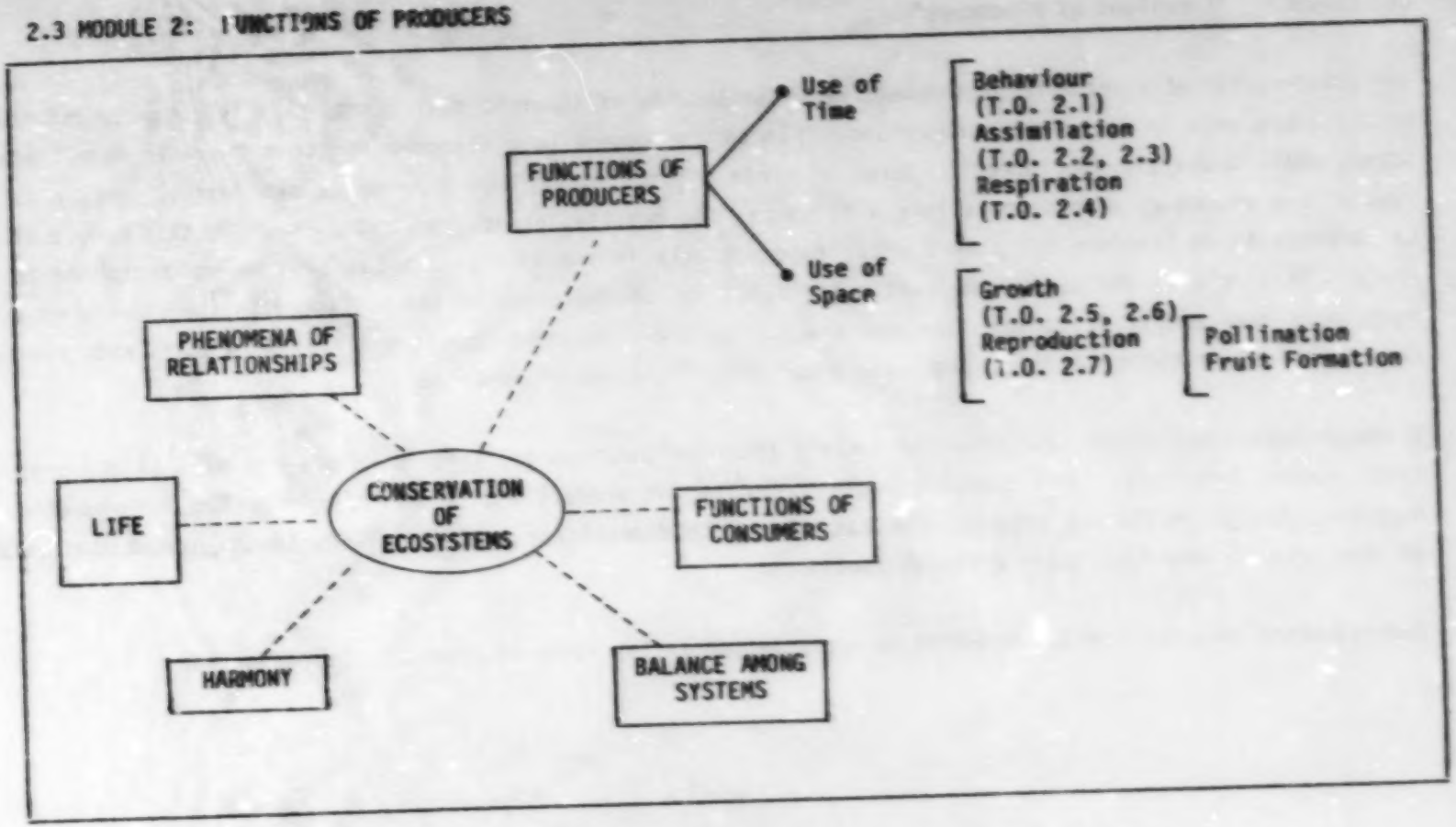
Ask the teams to suggest and illustrate possible solutions.

CONTENT	TERMINAL OBJECTIVES: 1.11 - 1.12	LEARNING ACTIVITIES
		Organize a mini-exhibit of the pupils' work.
	Evaluation:	Artistic expression is one of the principle pathways to social commitment. Exhibiting pupils' work will stimulate their interest by heightening their sense of self-esteem. Be sure that the message is accurate; both the message and the presentation should be evaluated. See Section 1.3.4.
	Example 27:	PERFORMANCE ACTIVITY FOR OBJECTIVES 1.11 AND 1.12
		TOPIC: Use of Resources
	Focus of Learning:	Activities that are essential to man's way of life.
	Skill:	To know how to solve a problem related to a given situation.
	Time:	15 minutes, plus time spent on the survey.
	Materials:	Newspaper and magazine clippings, etc.
	Teaching Strategy:	Field Investigation (Survey), see Section 1.3.3(a).
	Procedure:	Divide the class into three groups representing the elements used by man: water, air and land.

CONTENT	TERMINAL OBJECTIVES: 1.11 - 1.12	LEARNING ACTIVITIES
		Have pupils form teams of two. Ask the teams to prepare a number of questions on the advantages and disadvantages of a specific use of an environmental resource. E.g. Can you name one of the advantages of forestry? One disadvantage? A possible way to overcome the disadvantage? . Ask pupils to do a survey of the people in their neighbourhood (insist on anonymity). . Have them compile their results. . Ask pupils to draw their own conclusions and to record them. See Section 1.2.2 (b and f).
	Evaluation:	Teachers should be prepared to evaluate the questions and verify their relevance to the course content. Teachers may refer to the conclusions which pupils have recorded in order to determine whether their attitudes demonstrate greater concern for the environment as a result of this activity.

MODULE 2: FUNCTIONS OF PRODUCERS

2.3 MODULE 2: FUNCTIONS OF PRODUCERS



KEY CONCEPT: **"Functions of Producers"**

The conservation of plant life presupposes an understanding of the role that plants play in nature. Unfortunately, this role is largely misunderstood. Plants are generally considered in terms of their nutritional value, while trees are considered in terms of their utility as building material; even worse, certain tree species are viewed as nothing more than a nuisance. In reality, plants and trees, which in this module will be referred to as "producers," play a vital role not only in the environment but also in the biosphere as a whole. This role is defined by the particular functions of the organism and is linked to the structures and behaviours that enable it to use time and space. In order to ensure their survival, producers must reproduce, manufacture their own food, grow, and adopt specific forms of behaviour.

Although humans use plants and trees to satisfy their personal needs, these uses are not part of the producers' normal functions. For example, apple trees do not produce apples expressly for human consumption. However, through persistent efforts, man has managed to domesticate certain species to the extent that some of them seem to have lost their original functions.

Understanding this key concept requires an appreciation of the right of plants to be respected.

TABLE OF STRATEGIES FOR MODULE 2

Intermediate Objectives \ Teaching/Learning Strategies	A Field Investigation	B Laboratory Investigation	C Demonstration	D Research	E Guided Class Discussion	F Oral Presentation	G Audiovisual Presentation	H Dramatization	I Written or Oral Report	J Worksheet Activity	K Community-Based Project or Activity
T.O. 2.1											
2.1.1		* 2	*		*1*3				*2		
2.1.2		* 4	* 4		* 3						
2.1.3		*	* 5		* 3				*		
T.O. 2.2											
2.2.1			* 7								
2.2.2			* 8						* 6		
2.2.4			* 9								
T.O. 2.4											
2.4.4		*11			*10						

LEGEND: *: Suggested teaching/learning strategy
Nos. 1-13: Activity numbers

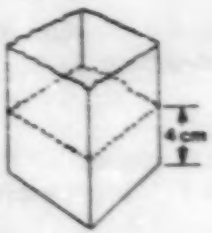
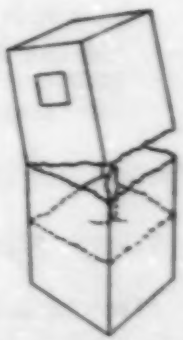
TABLE OF STRATEGIES FOR MODULE 2(cont'd)

Intermediate Objectives \ Teaching/Learning Strategies	A Field Investigation	B Laboratory Investigation	C Demonstration	D Research	E Guided Class Discussion	F Oral Presentation	G Audiovisual Presentation	H Dramatization	I Written or Oral Report	J Worksheet Activity	K Community-Based Project or Activity
T.O. 2.5											
2.5.1		*14			*12				*14	*13	
2.5.3		*15	*15								
T.O. 2.6											
2.6.1 to 2.6.3				*17	*16				*17	*16	
2.6.4				*20			*19		*20		
T.O. 2.8											
2.8.8			*22		*21				*22		

LEGEND: *: Suggested teaching/lea-ning strategy
Nos. 15-25: Activity numbers

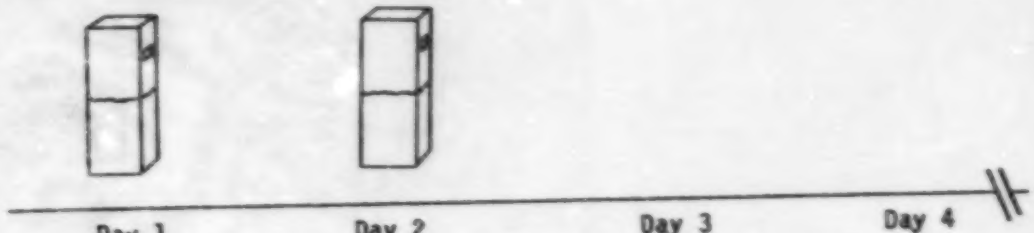
CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES
Plants react to external stimuli such as light, water and gravity. These phenomena, called tropisms, occur during a plant's normal development and are a reaction to the specific conditions of the external environment. Without going into great detail, these automatisms or built-in responses may be described as either "positive" or "negative responses" to a non-living element. The response itself consists of a bending movement whereby the degree of the curve is determined by the intensity of the external stimulus. By exerting a constant influence on the different parts of the plant, light, water and gravity cause opposite sides to grow at different speeds, often producing startling results.		Certain plant behaviours should be observed at the beginning of this module because these phenomena arouse a great deal of interest among pupils. Teachers may also use special set-ups to re-create specific external factors designed to stimulate pupil interest and imagination. Through these activities, pupils will be able to observe and record certain phenomena of relationships over a period of time. This section takes up the concept of "learning by observation" at the point where the first module left off. Pupils will be asked to monitor the behaviour of plants for an extended time period until they observe some changes. This may prove difficult for some pupils who are not accustomed to performing the same task for several days at a time. **Example 1:** MOTIVATION ACTIVITY FOR OBJECTIVE 2.1.1 **TOPIC: Plant Response to Light** **Focus of Learning:** Plant behaviour. **Time:** 5 - 10 minutes. **Materials:** Slides or posters: . slides showing the leaves of a coleus plant turning to face the light. . slides of a sunflower taken at different times of the day. . slides showing trees with very twisted trunks. Short animated films.

CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES
		Teaching Strategy: Guided Class Discussion. N.B. See Section 1.3.3(e).
		Procedure: Choose one or more slides. Project the slides in the classroom. Initiate a discussion: Do you think the behaviour of the sunflower or of the coleus leaves was normal? N.B. Refer back to Sections 1.2.2(a) and 1.3.2.
		Example 2: ACQUISITION ACTIVITY FOR OBJECTIVE 2.1.1 **TOPIC: Plant Response to Light**
		Focus of Learning: Plant behaviour.
		Skill: To record the specific characteristics of a phenomenon, based on observation.
		Time: 10 minutes per day, for 7 days.
		Materials: Sunflower seeds or bean seeds, a milk carton, soil mixture for plants.
		Teaching Strategies: Laboratory Investigation and Written or Oral Report. N.B. See Section 1.3.3(b and i).

CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES
	Procedure:	Use an empty container and cut it as illustrated in the diagram below:
		Cut a 3 cm opening in one side of the container. Fill the container with a plant soil mixture or cotton wool.
		Plant a seed. Keep the soil suitably moist for the duration of the experiment. Turn the container so that the opening is facing a source of light. Wait.

CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES

WORKSHEET



Based on your observations, draw a picture of the plant on each day of the experiment.

On the seventh day, describe how the young plant has grown.
N.B. See Sections 1.2.2 (b-g-h) and 1.3.4 (b-e-f).

Questions:

- Look at all the drawings and describe what has happened and how.
- Regardless of the results of the experiment, try to come up with a simple conclusion. Explain the results.

Example 3: MOTIVATION ACTIVITY FOR OBJECTIVES 2.1.1 TO 2.1.3

TOPIC: **Plants Are Sensitive**

Focus of Learning: Plant behaviour.

CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES
		Time: 10 - 15 minutes.
		Materials: Plants displaying nastic movement. (e.g. Mimosa plant). Photographs illustrating a nyctinastic movement (e.g. the dandelion "opens" its petals in the day and "closes" them at night).
		Teaching Strategy: Guided Class Discussion.
		Procedure: Show pupils the materials and lead them to discuss the fascinating nature of the phenomena. Help pupils understand that plants do manifest behaviour.
		Example 4: ACQUISITION ACTIVITY FOR OBJECTIVE 2.1.2 **TOPIC: The Pull of Gravity**
		Focus of Learning: Plant behaviour.
		Skill: To know how to record characteristics.
		Time: 5 - 10 minutes per day, for several days.
		Materials: Test tubes, paper towels, adhesive tape, small sunflower or corn plants.
		Teaching Strategy: Laboratory Investigation or Demonstration.

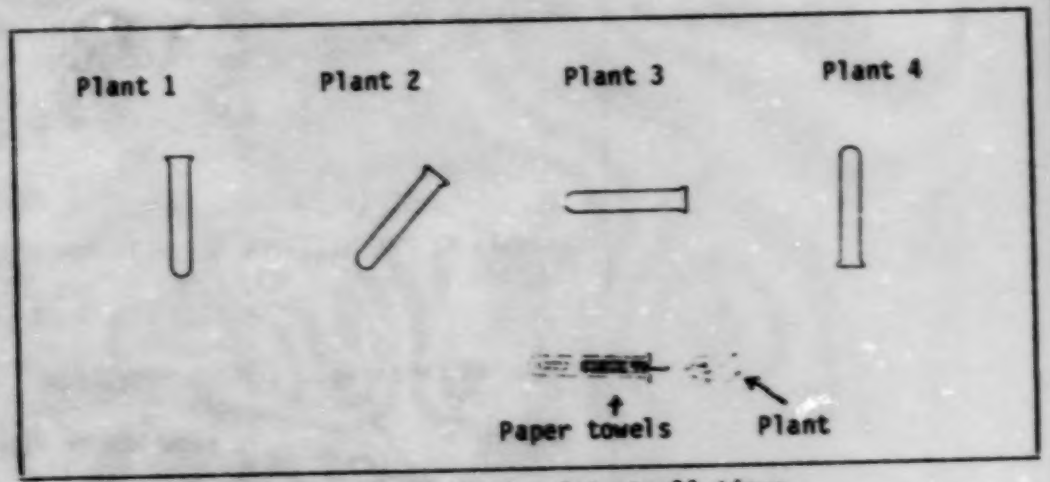
CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES

Procedure:

For the demonstration, the equipment should be set up as shown in the following sketch.

For the laboratory investigation, the equipment can be set up at school or at home as shown in the following sketch.

The equipment should be set up in a dimly lit location.

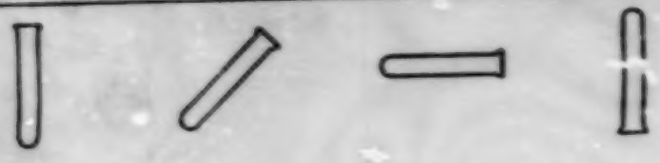


N.B. The paper towels must be kept moist at all times.

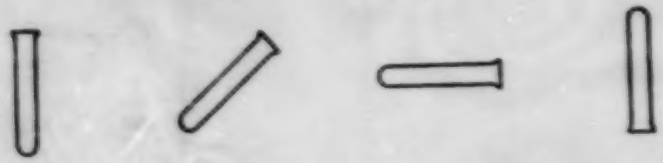
CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES

Prepare a worksheet as follows, with as many days as necessary to record the phenomenon:

Day 1:



Day 2:



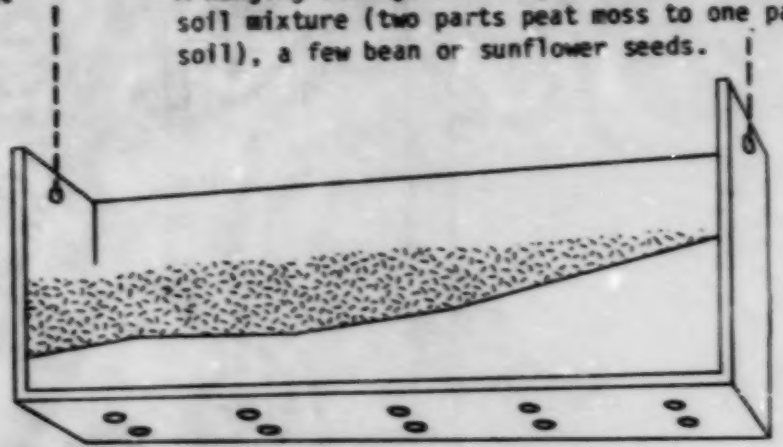
- Place your plants in the test tubes (4 plants in 4 test tubes)
- Position the test tubes at different angles as illustrated.
- Make drawings of the plants, based on your observations.
- Record all aspects of the phenomenon in detail.

Questions:
. Can similar phenomena be observed in nature?
. Etc.

Example 5: ACQUISITION ACTIVITY FOR OBJECTIVE 2.1.3

TOPIC: Root Attraction to Water

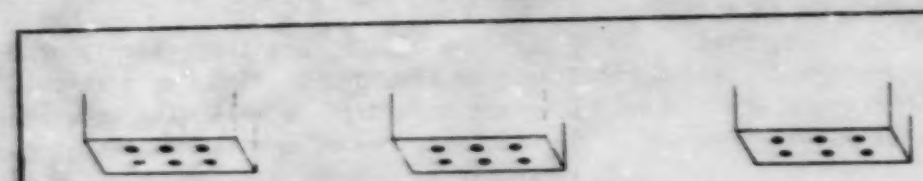
Focus of Learning: Plant behaviour.

CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES
	Skill:	To know how to record characteristics.
	Time:	10 minutes a day for approximately 15 days.
	Materials:	A hanging seed-germinating box (see sketch), plant soil mixture (two parts peat moss to one part soil), a few bean or sunflower seeds.
		
	Teaching Strategy:	Demonstration.
	Procedure:	This activity may be combined with another. Plant the seeds in soil in the seed-germination box. Add enough water to keep the soil moist. Hang the box in a visible location in the classroom. Ask pupils to take note of the specific characteristics of the phenomenon as it develops.

CONTENT	TERMINAL OBJECTIVE: 2.1	LEARNING ACTIVITIES

Prepare a worksheet (see below).
N.B. It will take a few days before the roots begin to appear.

WORKSHEET



N.B. Make a drawing of the roots, based on your observations.

Questions:

As the taproot and branching roots of the plant begin to penetrate the bottom of the germinating box, the roots are being drawn downwards; however, this movement changes very abruptly. Is there such a thing as competition between different forces of attraction?
Have you seen similar phenomena occuring in nature?
Etc.

CONTENT	TERMINAL OBJECTIVE: 2.2	LEARNING ACTIVITIES

In the introductory module, a producer was defined as a living organism which absorbs nonliving substances and transforms them into living matter. In fact, this particular form of feeding is the main feature which distinguishes plants from animals.

The question is, exactly how do plants feed themselves? The answer is not immediately apparent, although everyone knows, water and light play a vital role in the process.

The words "sugar," "carbon dioxide" and "oxygen" have been used in this module because they are suitable for pupils at this level.

Once again, the observation of plant responses will require special set-ups. Because these phenomena take time to develop, the observation activities should be spaced over several days. Film loops and slide shows can be valuable aids in carrying out this project.

In view of the fact that this is an observation activity, the class will not be required to find explanations for the behaviours observed. In a given situation, pupils will be asked to formulate some assumptions or hypotheses based on their observations of a specific phenomenon. It should be remembered that an assumption is not necessarily a definitive statement. It is a logical inference based on a number of related observations. Above all, it does not have to be the correct interpretation of what is being observed. Example: When a potted plant is placed on the windowsill, the leaves will turn to face the light.

If pupils encounter any difficulties, the teacher can always go back to an observation activity or focus attention on a particular pupil's questions. Finally, it is preferable to have pupils record their observations in writing.

Example 6: ACQUISITION EXERCISE FOR OBJECTIVE 2.2.2

TOPIC: Stating Assumptions

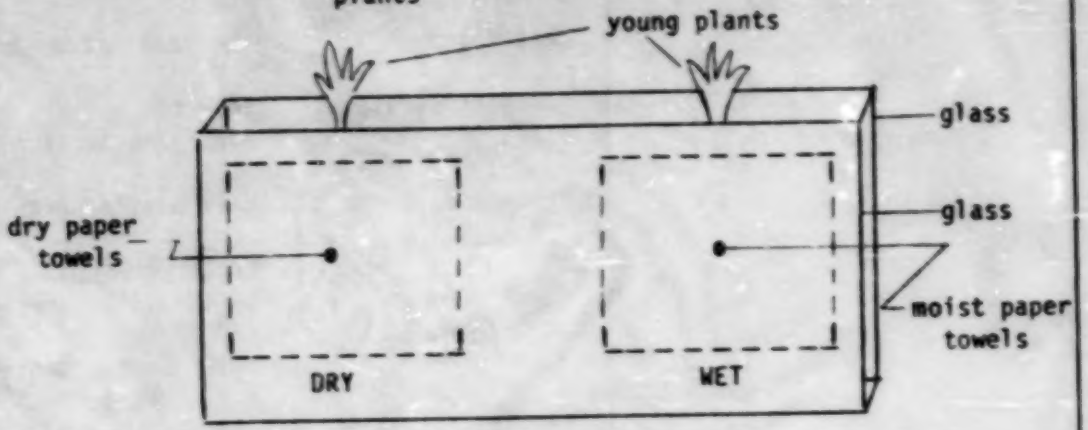
Focus of Learning: Elements involved in the process of assimilation or photosynthesis.

Skill: To know how to state assumptions.

CONTENT	TERMINAL OBJECTIVE: 2.2	LEARNING ACTIVITIES
		Time: 10 minutes per day, for 15 days. **Materials:** The same set-up as in Objective 2.1.1. **Teaching Strategy:** Report. N.B. See Section 1.3.3(i). **Procedure:** Have pupils work in teams. Encourage pupils to discuss the process of photosynthesis as they carry out the experiment. Build on the pupils' initial representations. N.B. See Section 1.2.2(f). **Questions:** . Regardless of the results of the experiment, can you formulate any assumptions to explain the phenomenon or phenomena observed? . Explain your assumptions. **Example 7:** ACQUISITION EXERCISE FOR OBJECTIVE 2.2.1 **TOPIC: The Importance of Water for Plant Roots** **Focus of Learning:** Factors involved in the process of assimilation. **Skill:** To know how to state assumptions. **Time:** A few minutes a day for several days.

CONTENT	TERMINAL OBJECTIVE: 2.2	LEARNING ACTIVITIES

Materials: Glass seed-germination box (see sketch), 2 young plants



Teaching Strategy: Demonstration.

Procedure:

Hang or place the box in a suitable location in the classroom.

Ensure that the moist paper towels are kept sufficiently moist throughout the duration of the experiment.

Give pupils worksheets on which to record their observations, i.e. drawings with comments (see sample worksheet).

Encourage pupils to supplement their comments with assumptions.

N.B. Do not insist on an explanation if a pupil is unable to offer one.

CONTENT	TERMINAL OBJECTIVE: 2.2	LEARNING ACTIVITIES

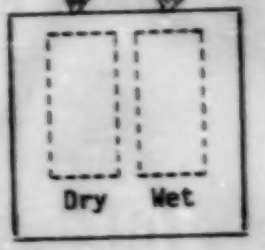
WORKSHEET

Draw on the following charts your observations of the growth of the 2 young plants' roots and leaves.

Comments

1st observation:

2nd observation:



Further observations:

Assumptions: _____

Questions:

What have you discovered in this experiment about the importance of water to plant development?
Etc.

CONTENT	TERMINAL OBJECTIVE: 2.2	LEARNING ACTIVITIES

Example 8: ACQUISITION ACTIVITY FOR OBJECTIVE 2.2.2

TOPIC: The Importance of Light

Focus of Learning: Elements involved in the process of assimilation.

Skill: To know how to state assumptions.

Time: A few minutes a day for about 7 days.

Materials: Empty milk cartons, sunflower or bean seeds, plant soil mixture.

Teaching Strategy: Demonstration.

Procedure: First, have pupils germinate and grow several plants. See Example 2, T.O. 2.1 for model.

Have them place one plant where there is a source of light.

Have them place another plant in darkness (for example, cover it with opaque paper).

Give pupils worksheets on which to record their observations, e.g. drawings with comments (see sketch).

When a number of observations have been recorded, encourage pupils to supplement their comments with assumptions. However, do not look for explanations.

CONTENT	TERMINAL OBJECTIVE: 2.2	LEARNING ACTIVITIES

WORKSHEET

Comments

1st observation:

light darkness

2nd observation:

Further observations:

Assumptions: _____

Questions:

- What have you discovered in this experiment about the importance of light to plant development?
- Can you think of another experiment to demonstrate the importance of light?

CONTENT	TERMINAL OBJECTIVE: 2.2	LEARNING ACTIVITIES

Example 9: ACQUISITION ACTIVITY FOR OBJECTIVE 2.2.4

TOPIC: The Presence of Mineral Salts

Focus of Learning: Elements involved in the process of assimilation.

Skill: To know how to state assumptions.

Time: 20 - 25 minutes.

Materials: A small branch, materials for burning, a scale.

Teaching Strategy: Demonstration, see Section 1.3.3.

Procedure: Give pupils worksheets (see below) on which to record the various data, their observations and one or more assumptions.

Conduct the following experiment:
. take a small branch from a tree
. measure its mass
. burn it thoroughly until only ashes remain
. measure the mass of the ashes when cool

Ask pupils to note every observable detail.

Ask pupils to formulate one or more assumptions based on their observations and the results of the experiment.

CONTENT	TERMINAL OBJECTIVE: 2.2	LEARNING ACTIVITIES

WORKSHEET

mass of branch ..... g

\- mass of ashes ..... g

"what has been lost" ..... g

Observation:

Assumption(s): .....

Questions:

- Why did the ashes not burn?
- Do ashes belong to the category of nonliving elements?
- Etc.

CONTENT	TERMINAL OBJECTIVE: 2.3	LEARNING ACTIVITIES
The principle function of plants is to feed themselves autonomously, and for this reason they are called producers. This function is accomplished through a process called "assimilation" (chlorophyllous) during which a plant absorbs water and mineral salts from the soil, inhales carbon dioxide from the air and traps the rays from the sun. These three functions work together to form organic food substances called "sugars." In the same process, a gas called "oxygen" is released into the air. Oxygen is essential to animal life, and plants are the main producers of this substance.		The learning principle of discovery through experimentation has been the focus of considerable attention. The understanding of certain phenomena is usually associated with the acquisition of new skills, and the experiments in this module have been specifically designed to link the two processes of logical thinking and practical activity. Investigations are valid and useful insofar as they enable pupils to develop consistent work methods and avoid fragmented or repetitive activities. This does not necessarily imply that demonstrations have to be perfectly executed or that experiments must have successful results. Pupils will develop their personal understanding of a phenomenon only to the extent that new information is added to modify or expand their grasp of the initial concept. In some cases, the pupil can learn more from negative or erroneous results than from a proven fact. Consequently, concept formation appears to be more closely linked to the manner in which the idea is assimilated, i.e. the learning process, than to the specific content learned. At some point, the class may be unable to make further progress for various reasons. The teacher may then give pupils new instructions or provide additional information that will help them come up with new ideas.

CONTENT	TERMINAL OBJECTIVE: 2.4	LEARNING ACTIVITIES
Plants are capable of manufacturing their own food. However, if deprived of sunlight, which is their principle source of energy, plants, like animals, will draw energy from their reserves to ensure their survival. Known as "respiration," this phenomenon is a process by which plants feed upon themselves, using the "sugars" in their leaves and the "oxygen" absorbed from the air. During this process, plants release carbon dioxide, water vapour and heat energy into the air.		See Terminal Objective 2.3 Example 10: MOTIVATION ACTIVITY FOR OBJECTIVE 2.4.4 TOPIC: Plants and Animals Breathe Focus of Learning: The process of transpiration. Time: Unspecified. Materials: 1 plastic covering or 1 large glass jar, and one indoor plant (coleus). Teaching Strategy: Guided Class Discussion. Procedure: Have pupils place the plant under the plastic covering or inside the glass jar. Have them observe the plant until they see evidence of transpiration. Have pupils record all information which may be relevant to the experiment. Initiate a discussion: "Who can offer an explanation?" (The explanations should be stated as assumptions, not as definitive statements.)

CONTENT	TERMINAL OBJECTIVE: 2.4	LEARNING ACTIVITIES

Example 11: ACQUISITION ACTIVITY FOR OBJECTIVE 2.4.4

TOPIC: Plants Breathe Too

Focus of Learning: The phenomenon of transpiration in a plant.

Skill: To know how to choose a simple procedure to verify a given assumption.

Time: 30 - 45 minutes.

Materials: A glass dome or a clear plastic cover, a small geranium or other type of plant, 2 flower pots, a plastic bag, plant soil mixture.

Teaching Strategy: Laboratory Investigation.

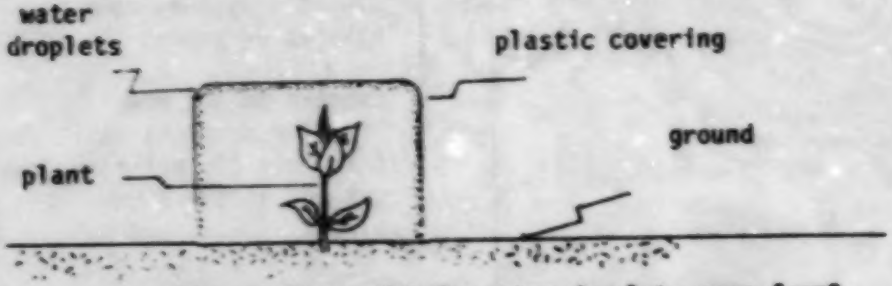
Procedure: Give pupils worksheets describing a situation.

Formulate one or more assumptions related to this situation and give a few guidelines or suggestions to direct or assist pupils in their learning.

CONTENT	TERMINAL OBJECTIVE: 2.4	LEARNING ACTIVITIES

Situation: Gardeners often cover their plants to protect them and to guard them against frost towards the end of summer (e.g. tomato plants). One sunny morning, while observing the plastic coverings, a gardner was surprised to see water droplets on the inner surface of the coverings (see following diagram).

However, she was assured that the plants had not been watered in the past few hours.



Where, then, did the water droplets come from?

- Is it possible that they came from the plant itself?
- Is it possible that they came from the ground?

Can you think of an experiment that would help to explain this situation?

CONTENT	TERMINAL OBJECTIVE: 2.4	LEARNING ACTIVITIES

This suggestion may be helpful.

Example on the left:
If water droplets still form inside the covering, it can be concluded that they come from the soil because the plastic covering was sealed around the pot, but not around the plant.

Example on the right:
If water droplets still form inside the covering, it is certain that they did not come from the plant because the plant has been cut off at the stem.

Questions:

- What can you deduce from this experiment?
- Can these assumptions be verified by any other means?
- Did you think of a different experiment from the one suggested?

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES
Growth is one of the functions of producers. During growth, matter and energy are stored in the different parts of the organism. The rate of growth depends on the quality and quantity of nutrients derived from the soil and on the ambient conditions.		Observing the germination and growth of a plant is a good way for pupils to gain experience in working independently. Furthermore, the daily recording of information is an activity that can easily be done at home. In the first module, pupils learned how to construct a simple graph; this skill can now be further developed by introducing more challenging exercises. Given that pupils will be required to control a variety of experimental factors (elements, structures), they should always remember to use one plant as a control subject. All data should be transferred onto a graph. At this point in the course, pupils may be asked to trace two bell curves, each on a separate graph. The choice of graph paper will depend on the learning objective. For best results in the germination activities, use bean or sunflower seeds. Various indoor plants may also be used and can serve to introduce pupils to horticulture. Plant germination is always a somewhat mysterious phenomenon. Anticipation of change spurs the imagination and inspires pupils to contemplate the processes which are part of life. N.B. Pupils should exercise dexterity in conducting these experiments to ensure successful results.

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES

Example 12: MOTIVATION ACTIVITY FOR OBJECTIVE 2.5.1

TOPIC: Germination and Growth

Focus of Learning: The importance of light and water in germination.

Time: Unspecified.

Materials: Photographs, slides or film loops showing the growth of a bean or some other plant.

Teaching Strategy: Guided Class Discussion.

Procedure: Show the slides or films.

Initiate a discussion on the films or slides; invite pupils to formulate various assumptions on the process of germination.

Example 13: ACQUISITION ACTIVITY FOR OBJECTIVE 2.5.1

TOPIC: Growth

Focus of Learning: The importance of water to the growth of a plant.

Skills: To know how to plot a graph based on two variables.
To know how to coordinate the results of observations made over a period of time.

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES
	Time:	Unspecified.
	Materials:	Pair of scissors, glue, worksheet.
	Teaching Strategy:	Worksheet Activity, see Section 1.3.3(j).
	Procedure:	Give each pupil 2 worksheets (see following diagram) with the results of the two different growth experiments. Ask each pupil to construct the graphs using the given data, to indicate the quantities of water used in the experiments, and to illustrate the plants' growth using the appropriate cut-out illustrations.

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES

WORKSHEET 1

GROWTH OF A BEAN

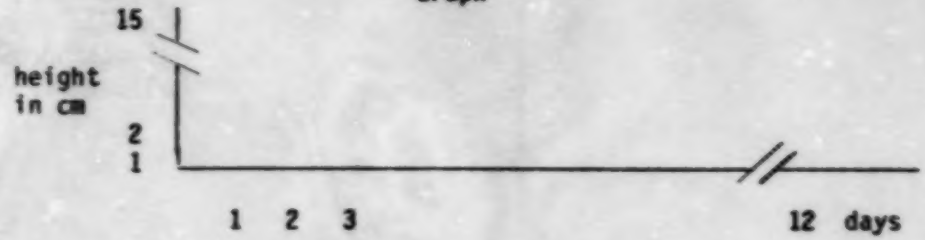
1st experiment: Length of the stem

N.B. Quantity of water used: 6.0 ml per day

THE FOLLOWING DATA WAS COLLECTED DURING AN EXPERIMENT:

day 1:	0	day 5:	1.0 cm	day 9:	9.0 cm
day 2:	0	day 6:	2.0 cm	day 10:	11.0 cm
day 3:	0	day 7:	4.0 cm	day 11:	13.0 cm
day 4:	0.5 cm	day 8:	6.0 cm	day 12:	15.0 cm

Graph



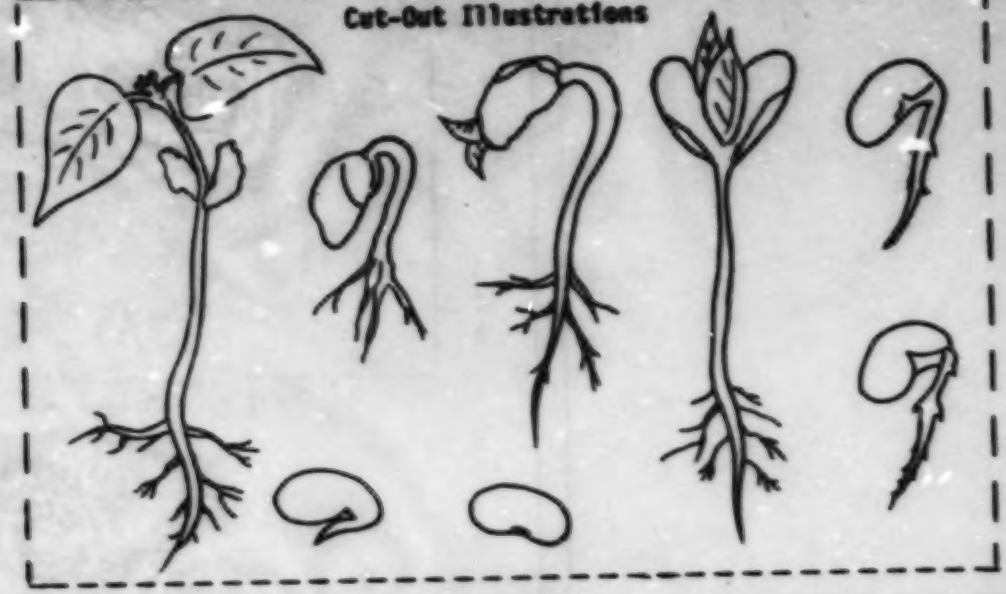
Quantity of Water

— — — — — — — — — — ml

Illustrations

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES

Cut-Out Illustrations



WORKSHEET 2

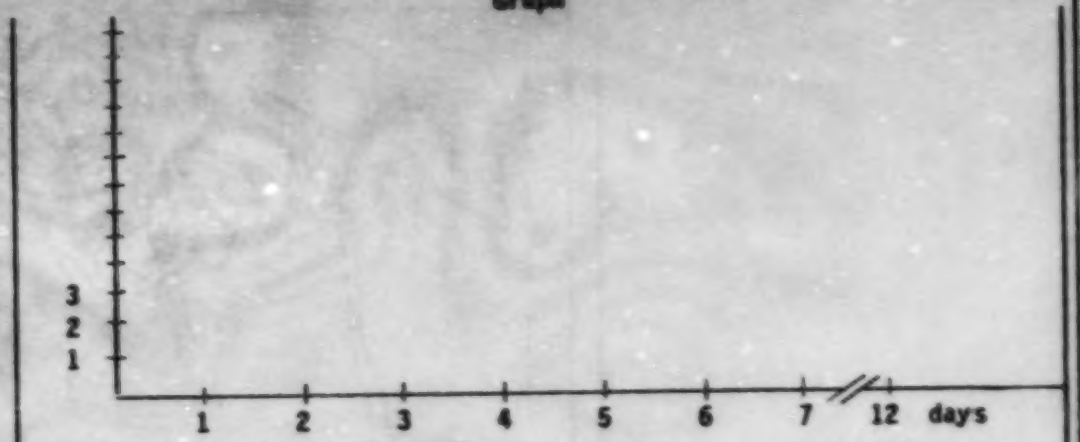
2nd experiment: Length of the stem
N.B. Quantity of water used: 3.0 ml per day

THE FOLLOWING DATA WAS COLLECTED DURING THE EXPERIMENT:

day 1: 0 cm	day 5: 0.5 cm	day 9: 2.5 cm
day 2: 0 cm	day 6: 1.0 cm	day 10: 3.0 cm
day 3: 0 cm	day 7: 1.5 cm	day 11: 3,0 cm
day 4: 0 cm	day 8: 2.0 cm	day 12: 3.5 cm

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES

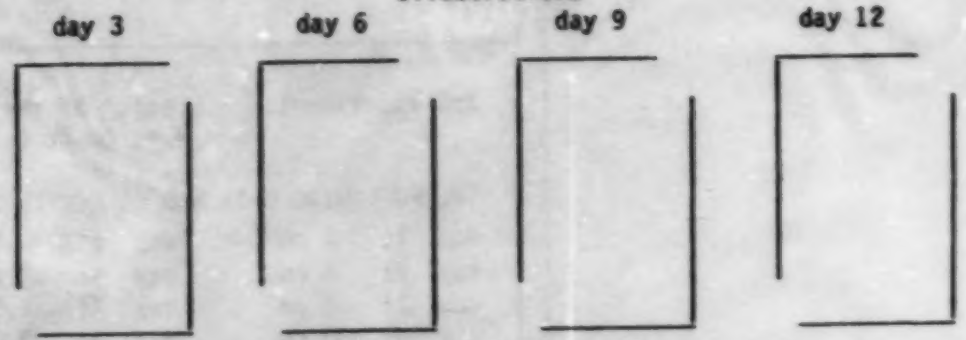
Graph



Quantity of Water

ml

Illustrations



CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES

Cut-Out Illustrations

QUESTIONS

. In comparing the results of the two experiments, find a plausible explanation to justify why one plant grew faster than the other (give supporting evidence).

. Can you name any other possible explanations for this phenomenon (without necessarily giving supporting evidence)?

. Etc.

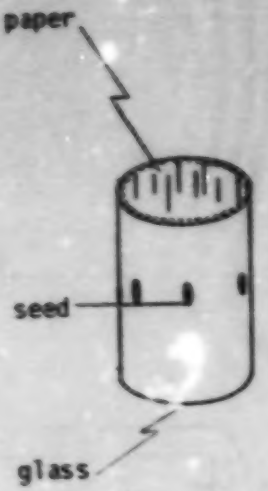
CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES

Example 14 PERFORMANCE ACTIVITY FOR OBJECTIVE 2.5.1

TOPIC: Growth

Focus of Learning:	The importance of water to the growth of a plant.
Skills:	To know how to construct a graph based on two variables. To know how to coordinate observations made over a period of time.
Time:	A few minutes a day for a specific number of days.
Materials:	2 glasses, paper towels, bean or sunflower seeds.
Teaching Strategies:	Laboratory Investigation and Report, see Section 1.3.3(i).
Procedure:	Have pupils do the following experiment: Line a glass with paper towels. Place a ball of crumpled paper inside the glass to hold the paper lining in place. Repeat the procedure with the second glass, using the same amount of paper.

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES



Moisten the paper inside the containers thoroughly with water.

Place three or four seeds in each glass between the glass and the paper towels, 4 to 5 cm from the bottom of the glass.

Once a day, sprinkle the first container with X ml of water and sprinkle the second container with X/2 ml of water.

N.B. Quantity X will depend on the size of the container; make sure that the paper lining is kept uniformly and thoroughly moist.

Prepare two identical worksheets (see following diagram) large enough to accommodate the drawings and the graphs.

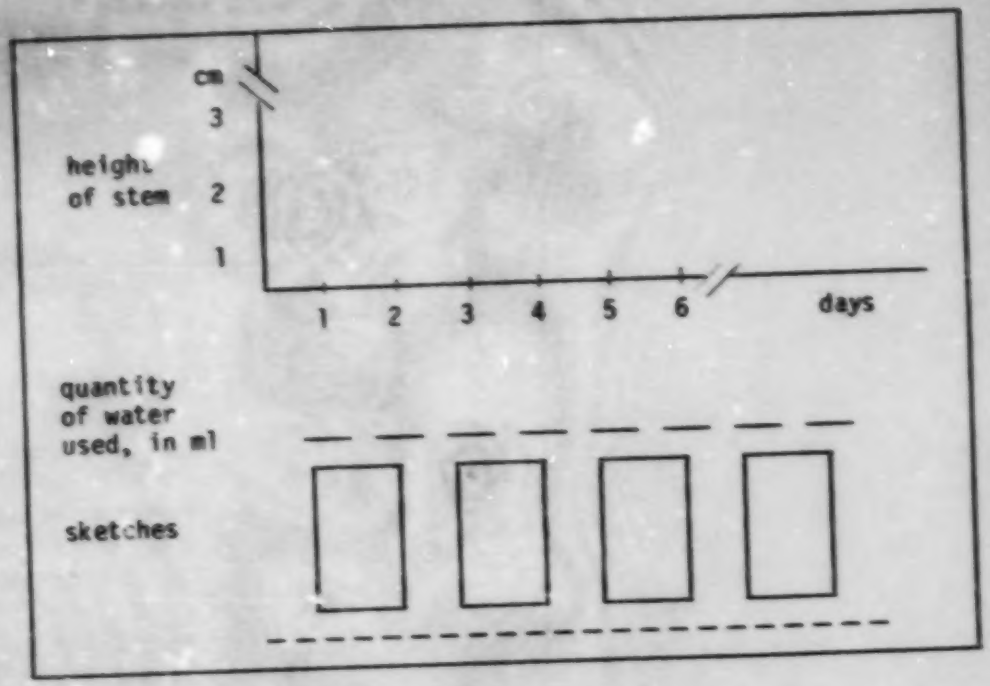
Record the quantities of water used each day beginning on Day 1 (in ml).

When the small plants unfold, record the length of their stems (in cm) each day and plot the results on the graphs.

Draw sketches of the plants each day to show how they have grown.

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES

WORKSHEET MODEL



Questions:

- By comparing the two worksheets, explain how important water is to the development of a plant.
- Did you notice anything particularly interesting during the course of the experiment?
- Etc.

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES
	Evaluation:	This activity will be meaningful only if it is preceded by an acquisition activity. The performance evaluation initially focuses on the pupils' ability to identify the steps involved in the germination and growth of a plant. This phenomenon is affected by different conditions, however, and does not always occur uniformly. At this stage in the year, teachers can expect pupils to know how to coordinate their observations. Pupils may also be evaluated on their ability to construct graphs. Later on, the two curves may be superimposed in order to help pupils draw additional conclusions.
	Example 15:	ACQUISITION ACTIVITY FOR OBJECTIVE 2.5.3 TOPIC: The Effect of Fertilizers on Plant Growth
	Focus of Learning:	Germination and growth.
	Skills:	To know how to construct a graph based on two variables. To know how to coordinate observations made over a period of time.
	Time:	A few minutes a day, for a specified number of days

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES
	Materials:	Plant soil mixture, two identical containers, commercial fertilizer solution, sunflower or other types of seeds.
	Teaching Strategy:	Laboratory Investigation or Demonstration.
	Procedure:	Have pupils pour soil mixture into the two containers. Have them plant 5 seeds in each container. One of the containers, labelled "control," is to be watered daily with x ml of water (x will depend on the size of the containers). The other container, labelled "experimental," is to be watered daily with x ml of the fertilizer solution. Prepare a worksheet on which each pupil can record the data on the five plants in each of the two experiments (see following diagram). Have each pupil construct a graph using the averages of the data collected for each of the containers.

CONTENT	TERMINAL OBJECTIVE: 2.5	LEARNING ACTIVITIES

WORKSHEET

			Days												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
Control	1															
	2															
	3															
	4															
	5															
	Average															
Experimental	1															
	2															
	3															
	4															
	5															
	Average															

Questions:

- Can you state with certainty that the use of chemical products can speed up the growth of plants?

- Etc.

CONTENT	TERMINAL OBJECTIVE: 2.6 to 2.8	LEARNING ACTIVITIES

By analyzing plant activities related to their nutritive, reproductive and growth functions, pupils can develop a better understanding of the living nature of these producers. Though it is not always apparent, plants react to their environment in specific ways, according to factors related to time and space. Their development can therefore be traced in terms of daily, seasonal, annual and periodic cycles, and it can be seen that each part of the plant has a particular role to play as these cycles unfold.

Plants normally occupy space in the environment in accordance with various natural principles. Several members of the same species will form a population. Different populations of plants with certain common features will then group together in the same area to form a community.

In order to facilitate learning, the activities of a plant are presented as separate processes, although, in fact, these processes are interactive and on-going.

This activity is a follow-up to Terminal Objectives 1.5 to 1.10. Reference material is required to supply pupils with additional information. The observation and experimental activities provide pupils with specific results; in order to organize, generalize and understand the significance of these results, it is essential that pupils consult a variety of reference material, whenever possible. At this stage, pupils still encounter two difficulties: identifying the parts of texts which correspond to specific questions and selecting the texts which provide the most specific answers to the questions. Lastly, the teacher should encourage pupils to talk about their findings, for they are bound to have come up with new questions in the course of the various learning activities covered in this module.

Example 16: MOTIVATION EXERCISE FOR OBJECTIVES 2.6.1, 2.6.2, and 2.6.3

TOPIC: The Life of a Tree

Focus of Learning: The role of the different parts of a tree.

Time: 10 minutes.

Materials: Photographs or montages illustrating, for example, a flower, a seed, a young or mature trunk, a leaf, and/or a root of one or more types of trees.

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES
Because the individual members of a community each have their own specific behaviours, the community is bound to evolve and undergo changes. These changes are part of a process known as ecological succession, which is characterized by a sequence of three separate stages: pioneer, intermediate and climax. Man has made certain discoveries about the various functions of producers and has learned to apply them to his benefit.		**Teaching Strategy:** Guided Class Discussion. **Procedure:** Show the photographs or montages. Initiate a short discussion: "What is the purpose of ... ?" **Example 17:** ACQUISITION ACTIVITY FOR OBJECTIVES 2.6.1, 2.6.2, and 2.6.3 **TOPIC:** The Life of a Tree **Focus of Learning:** The role of the different parts of a tree. **Skills:** To know how to answer a specific question with the aid of reference material. **Time:** 30 - 45 minutes. **Materials:** 16 mm film(s), reference books. E.g. N.F.B. or O.F.Q. films, books on botany, or relevant leaflets. **Teaching Strategies:** Research and Report, see Section 1.3.3(d) and (i). **Procedure:** Prepare some questions dealing exclusively with the topic under study. N.B. Considering the wide range of available reference material with suitable content no examples are given here.

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES
	Questions:	If a tree is a living thing, can it be compared to an animal in the sense that a tree occupies space and that its activities take place over time?
	Example 18:	PERFORMANCE ACTIVITY FOR OBJECTIVES 2.6.1, 2.6.2, and 2.6.3 TOPIC: The Life of a Tree
	Focus of Learning:	The role of the different parts of a tree.
	Skills:	To know how to answer a specific question with the aid of reference material.
	Time:	Unspecified.
	Materials:	Illustrated text(s) or monograph(s).
	Teaching Strategy:	Worksheet Activity, see Section 1.3.3(j).
	Procedure:	Hand out individual worksheets with a written text and illustrations and ask the pupils to match each picture with the appropriate passage in the text. Include one or more questions at the end of the worksheet for the pupil to answer.

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES

WORKSHEET

After the heavy spring rains, the sun finally emerges from the clouds.

Its warm rays penetrate the branches of the trees down to the ground, bathing the forest in a sea of warm, humid air.

With a slight quiver, the sprout stretches out its roots, anchors itself firmly in the ground and begins to absorb water and minerals from the soil.

Slowly, the seedling emerges from the ground. With its small coiled and twisted body, it looks more like a blade of grass than the sugar maple we know it to be.

The stem unfurls, supporting two food-storage organs called cotyledons at the top. The function of these two organs is to sustain the young plant for several days following seed germination.

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES
		Once the reserves have been depleted, the first two leaves take over by making food for the plant cells as they grow and divide. This food or nutritive substance circulates in the stem and is carried to the different parts of the young tree. The leaf is made of living tissue which breathes and transpires. Although it is an autonomous organism, the tree is directly dependent on the sun's energy to sustain its growth.
		Fifteen years later, the sapling shows little sign of having benefited from the sun's rays. Along with its siblings, it has grown in the shade of an old tree, and this has deprived them of the sunlight required to develop to their full height.
		One morning, the old tree collapses. The young tree must now compete for its place in the sun, for there is only one sunny spot to be claimed where the old tree once stood. How the young tree has grown! The trunk is now a fair size, able to support the treetop which is growing higher every day. The branches are forming thousands of new shoots covered with young leaves that dance in the wind. Even the roots are spreading and multiplying, assuring the maple a firm grip in the soil and reducing the eroding effects of the wind and the rain.

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES

At around its thirtieth year of life, the sugar maple reaches another important stage in its development.

With the arrival of the month of May, the tree's first flower buds burst open, realeasing a multitude of fragrances into the air.

Together, insects and warm breezes disperse the grains of pollen, pollinating the flowers and preparing the way for the development of fruit.

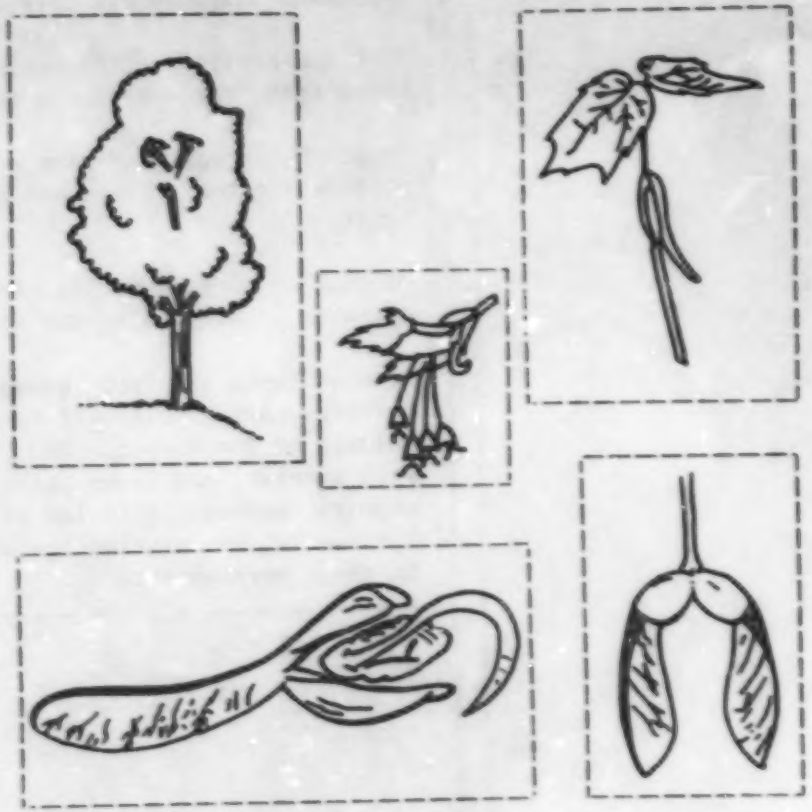
At the end of summer, the ripe fruit drops from the branches, strewing samaras* over the forest bed.

Some of these are lucky enough to fall on fertile soil; others land on rocks, are carried off by a stream, or serve as food for the animals of the forest. Among the seeds that take root, only a few will survive, and fewer still will grow to full term to become majestic maples. This law of natural selection works in favour of the species by ensuring the survival of those that have adapted best to their environment.

* T.N. The winged, usually one-seeded, fruit of the maple.

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES

Illustrations



CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES

Illustrations

QUESTIONS: . What is the function of the cotyledons?

. What is the function of the first two leaves?

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES
	Evaluation:	Pupils should be evaluated on their ability to identify different parts of a tree. In order to prevent this from becoming a memorization exercise, reference material should be provided to help pupils learn about trees.
	Example 19:	MOTIVATION ACTIVITY FOR OBJECTIVE 2.6.4
		TOPIC: Plant Succession
	Focus of Learning:	Plants' use of space.
	Time:	15 minutes.
	Materials:	Photographs, slide show, film loops or 16 mm film showing a peat bog or the evolution of a plant community.
	Teaching Strategy:	Audiovisual Presentation, see Section 1.3.3(g).
	Procedure:	Define certain key words such as: population, community, pioneer vegetation, subclimax species, climax species, aging, decomposition, growth, protection, invasion, shade.
		Show the films, photos or slides; stress the key words whenever possible.

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES
	Example 20:	ACQUISITION ACTIVITY FOR OBJECTIVE 2.6.4
		TOPIC: Plant Succession
	Focus of Learning:	Plant's use of time and space.
	Skills:	To know how to answer a specific question with the aid of reference material.
	Time:	Two or three 50-minute periods.
	Materials:	A variety of reference material (reference books, government publications, slide shows, etc.), materials for constructing a mock-up (paper, glue, tape).
	Teaching Strategies:	Research and Report.
	Procedure:	Ask pupils to illustrate plant succession in a given area: E.g. . lake ⟶ peat bog . abandoned field ⟶ forest. Suggest a few specific references, such as excerpts from a text (see following diagram) or audiovisual material used in the motivation activity.

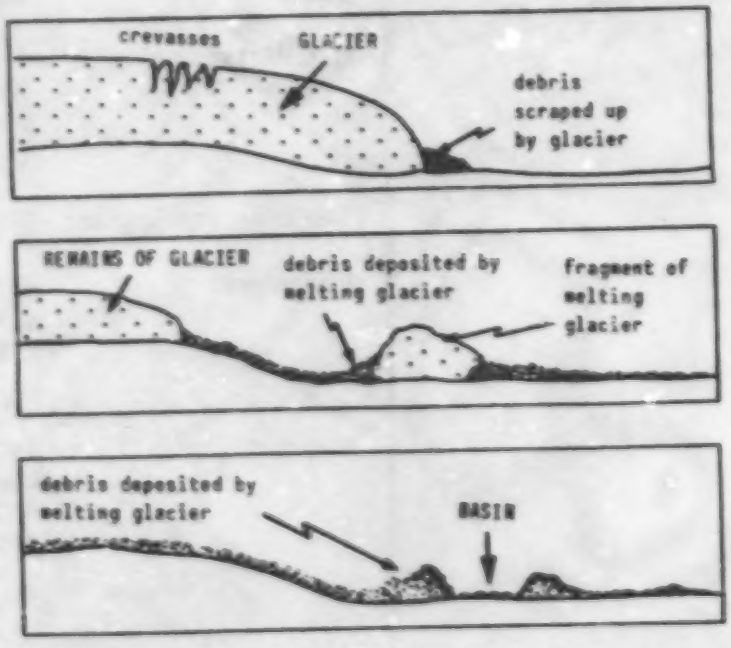
CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES

SAMPLE EXCERPTS FROM A TEXT

A MARSH LAKE DISAPPEARS

This lake was formed during the shift of the continental glaciers some 12 000 to 13 000 years ago. A glacier fragment broke off and melted, forming a basin with an impermeable bed.

LAKE FORMATION



CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES

FORMATION OF A PEAT BOG

A stretch of stagnant water can support very little animal life other than mosquitos. Because the water in a basin runs off very slowly, the water's oxygen level decreases while the level of acidity increases. These conditions serve to slow down the decay of the moss and plant life along the lakeshore. Consequently, the vegetation grows further and further into the lake, becoming denser and slowly filling up the basin. Over the years, as this process repeats itself, the surface area and depth of the lake slowly diminish.

peat: decaying moss and vegetable matter

In time, the stretch of water is completely covered, and the entire surface is transformed into peat bog. At this stage, the lake can be crossed on foot.

Source: "Le Marais"
Centre d'interprétation de la nature de Parke - Service de l'Education en conservation. Ministère de l'Énergie et des Ressources - Québec TF1-C 195.

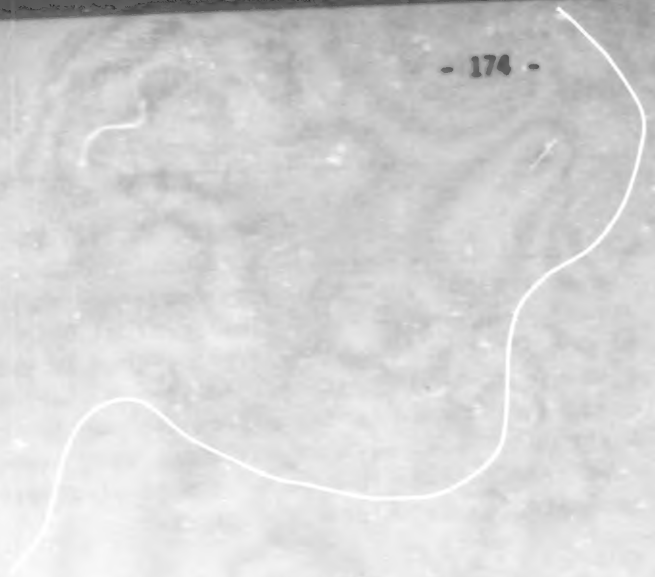
* T.N. The notations on the above diagrams are free translations.

CONTENT	TERMINAL OBJECTIVE: 2.6	LEARNING ACTIVITIES
		- Have the pupils work in pairs. - Ask the pupils to prepare a mock-up showing the different stages of succession and to present it to the class. Questions: . Do you have any idea how long it takes for a community to change? . Have you noticed any examples of plant evolution, such as the plantain growing in the school yard, the shrubs in an abandoned field, and so on? . Do you have a clearer understanding of the role of plants in the life of a lake?

CONTENT	TERMINAL OBJECTIVE: 2.8	LEARNING ACTIVITIES
	Example 21:	MOTIVATION EXERCISE FOR OBJECTIVE 2.8.8
		TOPIC: The Uses of the Sugar Maple (or Other Species)
	Focus of Learning:	Products made from a tree or a plant.
	Time:	10 minutes.
	Materials:	Photographs or posters illustrating the interior of a home where (maple) wood is used (wood panels, etc.).
		Sample reference: L'Arbre, un être vivant Min. de l'Énergie et des Ressources Service de l'Éducation en conservation ER1 3740-12
	Teaching Strategy:	Guided Class Discussion.
	Procedure:	Show the photographs or posters to the class.
		Have pupils name and discuss the various direct and indirect uses of a given type of tree.

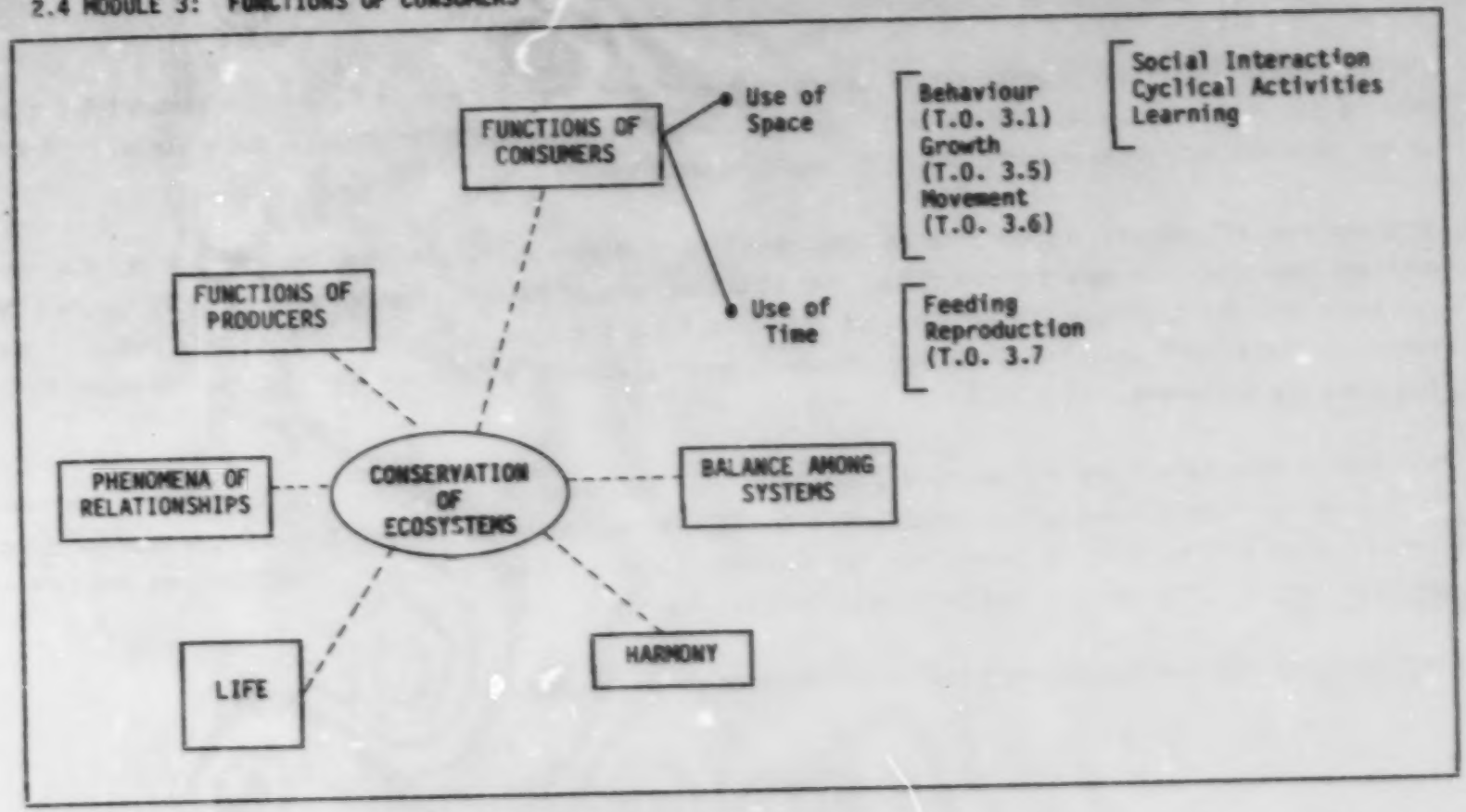
CONTENT	TERMINAL OBJECTIVE: 2.8	LEARNING ACTIVITIES
	Example 22:	ACQUISITION ACTIVITY FOR OBJECTIVE 2.8.8
		TOPIC: The Uses of the Sugar Maple (or Other Species)
	Focus of Learning:	Products obtained from a tree or a plant.
	Skills:	To know how to answer a specific question with the aid of reference material.
	Time:	Variable.
	Materials:	Various reference materials, either written or audiovisual, from public or private organizations.
	Teaching Strategies:	Research and Report, see Section 1.3.3(i).
	Procedure:	Prepare a research procedure outline for students to follow when carrying out a project demonstrating the uses of the sugar maple.
		Suggest some reference works.
		Encourage pupils to illustrate their presentations.
		Ask pupils to present their work to the class. See Section 1.3.4 (a) and (b).
	Questions:	Would you say that human beings make good use of trees?
		Have you found any information on the exploitation of other forest species?
		Etc.

CONTENT	TERMINAL OBJECTIVE: 2.9 and 2.10	LEARNING ACTIVITIES
Human beings have been exploiting plant life throughout history, and plants have figured prominently in the development of many civilizations. By using a large variety of plants to satisfy his ever-growing needs, modern man has managed to improve his standard of living. However, exploitation by humans is not one of the intended functions of nature's producers; pine trees were not intended to provide people with pulp and paper and building materials. In the exploitation of any type of resource, there is always a certain threshold which cannot be overstepped without risk of upsetting the delicate balance of nature. Plants cannot be expected to provide energy and raw materials indefinitely without their resources being depleted. An imbalance becomes increasingly evident in a forest where overexploitation causes soil erosion, contamination of waterways, loss of animal habitats, etc. The use of plants should therefore be considered a privilege granted by nature to the human species, and not something to be taken for granted.		These terminal objectives are presented as an extension of Terminal Objective 2.8. Like Terminal Objectives 1.11 and 1.12 of the first module, they are designed to encourage pupils to communicate their opinions and ideas. Subjects for possible activities should be drawn from the pupils' own environment. Having looked at ways in which man uses trees, this might be a good time to examine some of the negative aspects of man's exploitation of natural resources.



MODULE 3: FUNCTIONS OF CONSUMERS

2.4 MODULE 3: FUNCTIONS OF CONSUMERS



THE KEY CONCEPT: **"Functions of Consumers"**

The conservation of fauna presupposes an understanding of the role of fauna in nature. Unfortunately, this role is not well understood: animals are judged either on the basis of their food value, or worse, in terms of the problems and inconveniences caused by some species.

Nevertheless, all animals, referred to as "consumers" in this module, play an important role in the environment and have their own specific functions. The structures and behaviours of an animal enable it to use time and space in order to ensure its own survival and that of its offspring. The objective of this module is for pupils to learn about animal reproduction, feeding, growth, locomotion, and the specific ways in which these functions are performed.

Man uses animals to satisfy his own needs, but satisfying the needs of humans does not constitute a function of "consumers." For instance, the first animals to inhabit the forest did not exist for the purpose of being hunted. Furthermore, over the years, man has succeeded in domesticating certain animal species and consequently, many of these species have lost their original functions.

Understanding this key concept requires an appreciation of the right of all organisms to live.

CONTENT	TERMINAL OBJECTIVE: 3.1	LEARNING ACTIVITIES
Animals, a category of living things, were identified as consumers in the introductory module. Their main distinguishing feature is that they must search for the food they eat. However, eating constitutes only one of the many functions of consumers. Reproduction, growth and movement are some of the others. The many roles an animal plays in its environment can be described as social interactions within a population. In terms of relationships between individual members of a given population, the primary relationships in animals' lives are those which exist between males and females, between animals of the same gender and between parents and their young. A population of animals is composed of similar individuals, each of which uses a well-defined space and plays a specific role. The concept of ordered behaviour is analogous to the principle of survival. Animals have their own system of signals which they use to draw attention, to identify one another, to communicate their intentions, and so on. Furthermore, a society of animals is based on a hierarchy in which each individual knows its position in relation to the others in the group. Interestingly enough, humans conform to many of the rules governing the social interactions of animal populations.		Pupils should be encouraged to observe the activities and behavioural patterns of a given animal and to note its interactions with fellow animals and its environment. However, pupils may find it easier to describe a series of facts than to analyze the animal's specific movements and activities. Consequently, it is a good idea to give pupils worksheets listing questions on the topic of study in order to help channel their efforts and ensure an acceptable level of difficulty. The use of observation checklists will facilitate the task of completing a written report since pupils will only need to check off the principle actions observed. They will also be expected to recognize interrelationships between certain behavioural patterns so as to be able to draw conclusions. This is the only new observation skill to be introduced at this time.

CONTENT	TERMINAL OBJECTIVE: 3.2	LEARNING ACTIVITIES
Another facet of animal life is the use of time. Most animal activities occur in daily, annual and seasonal cycles. Every day, animals inspect their territory, tirelessly repeating numerous mobile or stationary exploratory activities. These activities are interspersed with periods of eating, grooming and resting. The behaviour of animals is guided by information received from the environment through the senses. Each sense organ is receptive to a specific set of stimuli which elicits a particular response (or reaction) from the animal.		Any animal behaviour, no matter how ordinary, is a suitable topic for classroom questioning. While bearing in mind that this is not an exercise in interpretation, the teacher should encourage pupils to formulate assumptions on the basis of one or more observable animal behaviours. As indicated in the previous module, an assumption is neither a definitive statement nor an attempt to provide an explanation. It is introduced by a question such as, "Is it true that...?" or "Is it possible that...?" If the chosen topics prove too difficult, the teacher can intervene by doing an exercise herself/himself or by answering pupils' questions. Lastly, pupils should be asked to state their observations in writing.

CONTENT	TERMINAL OBJECTIVE: 3.4	LEARNING ACTIVITIES
Animal behaviour encompasses all the attitudes and actions related to such common activities as reproduction, self-defense, the search for food and so on. These behaviours constitute a given response to certain specific determinants or stimuli. Seen in this light, an animal might appear to be nothing more than a robot, a being which is unable to think, plan, feel remorse, or to understand the concept of cause and effect. Animals exhibit two types of behaviours: innate and conditioned. Innate behaviours, such as maternal and territorial instincts, are inherent at birth and characteristic of the species. Conditioned or learned behaviours are acquired by developing conditioned responses to environmental stimuli. Learning new behaviours serves to improve the chances of survival for the species.		Again, the activities in this experimental sequence are designed to encourage pupils to take an investigative approach. Some pupils may not be sufficiently autonomous to begin an experiment on their own. In order to help them in this task, the teacher should propose an assumption related to the cause of the phenomenon under study. Subsequently, he/ she should suggest a procedure for verifying this assumption, indicating the individual steps to be followed. Pupils do not intuitively recognize the necessity for proving a given fact. Their empirical research is mostly limited to describing what they have done and arriving at a hasty conclusion. The pupils' ingenuity can be further stimulated through the use of a broad variety of experiments. The learning activities will require special set-ups which should be the responsibility of the pupils. Pupils should be required to base their conclusions on the results of the experiments. However, facts do not necessarily have to be proven in order for pupils to acquire a new representation of a phenomenon. The information given for Terminal Objectives 2.3 and 2.4 is relevant to this section.

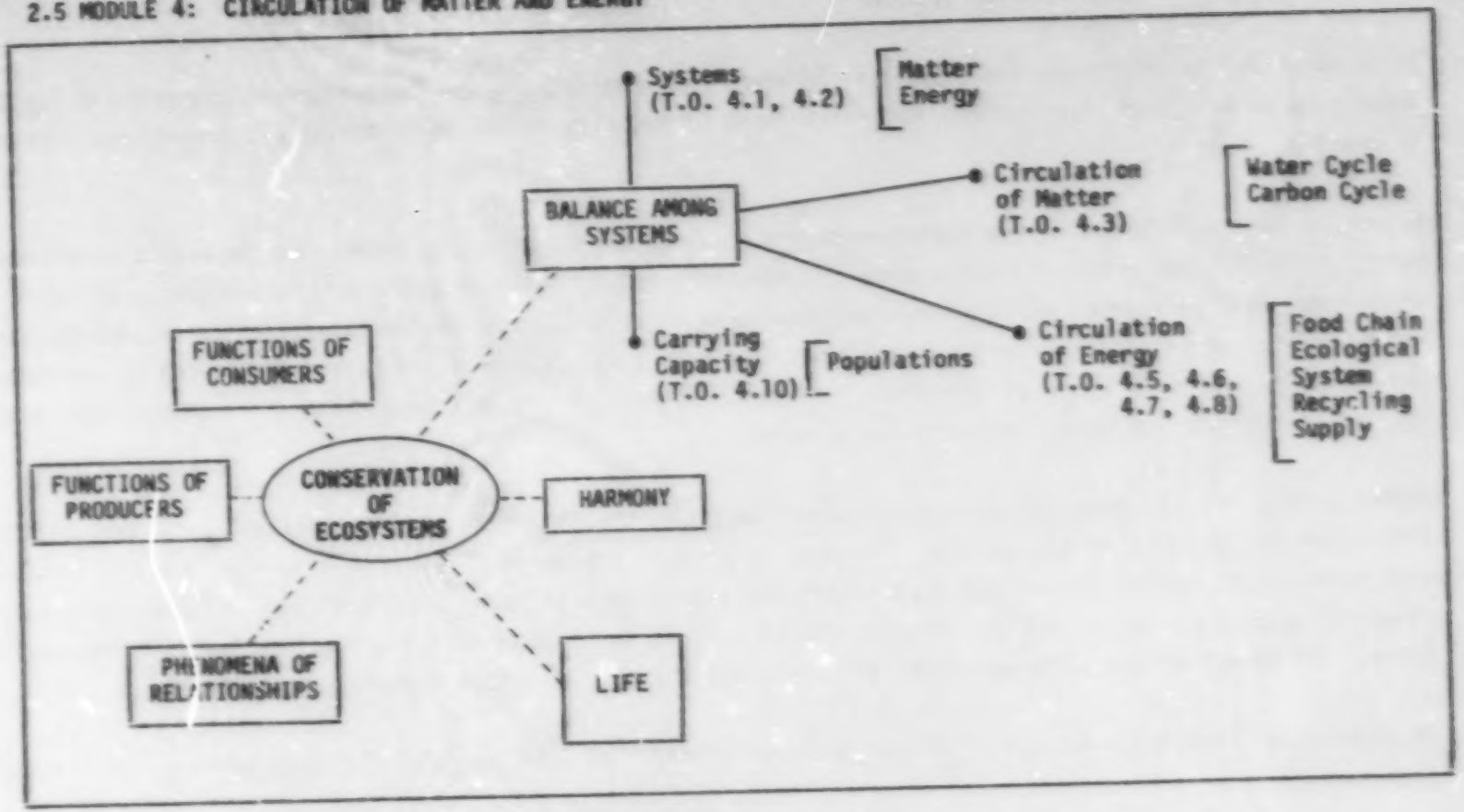
CONTENT	TERMINAL OBJECTIVE: 3.5	LEARNING ACTIVITIES
Growth is a vital characteristic in the development of a living organism which may be influenced by a variety of positive and negative factors. It consists of a progressive and irreversible gain in an animal's mass, height and volume during a limited period in the animal's life. Because the animal is a consumer, its body grows by absorbing the substances of both living and non-living things and by transforming these into the animal's own living substance. However, depending on the quality of its food intake as well as other factors related to the animal's activities, growth is not uniform in all organisms.		Teachers can accomplish some of their instructional objectives by raising animals in the classroom.* Monitoring the growth of an animal is an exercise that can be developed over several learning activities. This exercise helps pupils develop such skills as compiling data, constructing graphs, and so on. The information provided for Terminal Objective 2.5 is equally relevant to this section. Constructing a graph is a particularly important learning activity; at this stage, pupils can go beyond using collected data to plot a curve on a graph and try to make a prediction. For example, the data representing the growth of an animal over a period of seven to ten days can be used to predict the shape of the curve for the next few days. Monitoring the growth of an animal is not a trivial activity. It entails emotional involvement on the part of the pupil and can help him/her to modify certain negative attitudes. *Note: It should be borne in mind that keeping animals in the classroom entails extra work, cost for food, etc. and responsibility for the animal during weekends, holiday periods and at the end of the school year.

CONTENT	TERMINAL OBJECTIVE: 3.6 to 3.8	LEARNING ACTIVITIES
Generally speaking, animals' lives are regulated by how they use time and space. Their activities are governed by precise cycles and ritual behaviours. This phenomenon characterizes the functions of consumers. Movement is a well-known phenomenon of animal life which is normally associated with the search for food. However, an animal's locomotor activities are also directed towards exploring its personal range or territory. An animal perceives various elements of its environment and orients itself accordingly. Its survival is linked to a series of programmed activities comprising a variety of behaviour patterns. The more clearly these behaviour patterns are imprinted in the animal's brain, the greater the animal's chances for survival. Animals' movements vary from one species to another, depending on the physical structures which determine this function in the species. The same applies to reproduction, feeding and growth. Nevertheless, it is difficult to isolate one specific aspect of behaviour from the other functions, for all animal activity is oriented towards the satisfaction of individual needs.		Although life is a comprehensive process, animal activities are presented here as separate functions for the purpose of facilitating learning. Any acquisition activity introduced in this sequence and involving the use of reference material should require pupils to select carefully the exact passages in a reference book which pertain to a given problem. Some pupils may still have difficulty pinpointing the section of a text which corresponds to a specific question. It is therefore essential that learning be reinforced with various teaching aids and that pupils continue to be given fairly explicit guidelines. The teacher, on the other hand, should expect to see a greater degree of autonomy on the part of most of the pupils.

CONTENT	TERMINAL OBJECTIVE: 3.9 and 3.10	LEARNING ACTIVITIES
Rising consumption levels in our society are a growing concern. Changes within the family unit have contributed to the development of new consumer trends; these changes, together with improvements in modern commercial and industrial technology, have given rise to more sophisticated agri-food production and more frequent use of chemical processing and synthetic products. The move away from subsistence farming and self-sufficiency, the advent of mass advertising and the emergence of new consumer needs have all contributed to greater overproduction and excessive exploitation. The result is the depletion of fauna at an increasingly alarming rate.		A distinction should be made between the terms "advantages" and "proper use" as well as between "disadvantages" and "improper use". Proper use does not necessarily lead to advantages, and disadvantages do not necessarily stem from improper use. In order to encourage more in-depth thinking, pupils should be discouraged from proposing simplistic solutions or instant formulas. Using current examples, the class should identify some of the different ways man uses animals; pupils should suggest their own solutions to a specific problem or to a forseeable danger. All topics for discussion should be drawn from the pupils' own environment. For example, the teacher may encourage pupils to study local problems to see if there is a need for community projects and to look for local achievements that may be used as models.

MODULE 4: CIRCULATION OF MATTER AND ENERGY

2.5 MODULE 4: CIRCULATION OF MATTER AND ENERGY



THE KEY CONCEPT: **"A Balance Among Systems"**

It is important to understand how balance in nature is maintained, not for the purpose of achieving an ecologically balanced system, but rather, for the purpose of identifying the means by which a dynamic equilibrium is created.

Nature is both a life-sustaining environment and a system of relationships among interdependent organisms. Matter is circulated within a given system by means of energy. Plants require matter and energy to fulfill their functions; carnivores are dependent on herbivores while the latter are dependent on plants; decomposers require waste and carcasses in order to perform their role. Nature's delicate balance is linked to the population density of each group of organisms. A change within any one of these groups will always have some effects on the functioning of the system as a whole.

However, this natural state of balance does not apply to the human environment, and there is very little likelihood that it will in the future. Too many years have passed since the time when man lived in harmony with nature. It remains to be seen what effect the examination of human behaviour towards nature will have in arousing public concern and in inciting people to take steps to ensure their future survival and well-being. Man cannot afford to be negligent about the state of the earth's biosphere and its resources.

Understanding this key concept requires an appreciation of the essential interdependence of living organisms.

CONTENT	TERMINAL OBJECTIVE: 4.1	LEARNING ACTIVITIES
A system is defined as "a group of constantly interacting elements, organized to serve a common function."[1] Every system, whether it be an appliance or a business, an organism or an entire ecosystem, attempts to establish and maintain an equilibrium. The workings of a system are always the same: matter and energy enter the system and are called INPUT; as they leave the system, energy is used to transform the matter into a product or a result that is called OUTPUT. Energy enters the system in the form of food, motor fuel or force; it combines with matter to create useful work or a finished product. However, the transfer of energy always entails certain losses in the form of wastes, heat, etc. which occur at the end of the transfer.		Using the concept of a system will help pupils to gain a better understanding of the functioning of a natural environment. It is just as important to know how the elements are linked together as it is to understand the elements themselves. Paradoxically, pupils' understanding of the system as a whole is dependent upon their understanding of each of the elements that make up the system. Surprisingly, pupils have difficulty in making comparisons between structures that have the same function but a different form. The teacher can help them to overcome this problem by applying the basic principle of energy transfer to a variety of examples such as the human body, household appliances and so on. The ability to make comparisons represents a new stage in the development of observation skills.

1 Joël DE ROSNEY, Le macroscope - Vers une vision globale (Paris: Éditions du Seuil, Collections Points, 1975).
(The above citation is a free translation.)

CONTENT	TERMINAL OBJECTIVE: 4.2	LEARNING ACTIVITIES
Energy enables living organisms to perform life-sustaining activities and may be defined as the capacity to produce work or to effect changes. In order to grow, green plants must receive energy directly from light. This energy is stored in the plant structures in the form of vegetable matter. In order to grow, herbivores, on the other hand, must draw their energy from plants. The term "gross productivity" refers to the total quantity of energy derived from the food which is ingested by an organism. The term "losses" refers to the energy which is used up by the animal to sustain life. Examples of such losses are heat released by the muscles in movement, excrement, etc. As a young animal grows, a certain amount of energy called "biomass" is stored in its body. This biomass represents the "net productivity," or the difference between gross productivity and total losses. Every time an animal eats another animal or a plant, there is a transfer of energy with a yield of approximately 10% productivity.		The monitoring of an animal's growth will enable pupils to perfect their investigative approach; in this exercise, pupils will be required to monitor both the quantity of food eaten by an animal and the animal's mass. Data should be carefully collected over a set period of time: the results may serve to generate some interesting interpretations. This activity will enable pupils to grasp the full meaning of the concepts of gross productivity, loss, net productivity, energy output and biomass. Compiling data, controlling variables and constructing graphs are all skills that pupils will use in working on this objective. At this stage in the school year, pupils should be used to following an investigative approach in their learning activities. In view of the comments made in the sections on Terminal Objectives 2.3, 2.4 and 3.4, the teacher may now expect to see some changes in the pupils' work. Knowing how to interpret the results of an experiment is a challenge that represents an important skill for pupils to learn in developing a scientific approach. A calculator would be extremely useful in this exercise.

CONTENT	TERMINAL OBJECTIVE: 4.3 to 4.5	LEARNING ACTIVITIES
A cycle has no beginning and no end. It is based on the same model as a system: it requires matter and energy to function. For instance, the water cycle involves the circulation of water and the action of the sun. The carbon cycle involves the circulation of carbon and the action of the sun. In a food chain, matter and energy are circulated among producers, consumers and decomposers, and again this cycle involves the action of the sun. By identifying the prey of one or more predators and the food preferences of the local herbivores, it is possible to reconstruct the food web of a given area. A food web represents the interdependent system of food circulation in a given community and is composed of interrelated and overlapping food chains. By using a simplified food web as the point of departure, the teacher can focus on the concept of a food chain which by definition includes decomposers. In short, using the concept of a system enables pupils to gain a better understanding of how matter and energy circulate in nature and gives them an opportunity to explore the full implication of balance in nature.		Once pupils have learned to use documentation, they should be able to answer a specific question accurately with the aid of reference material. However, pupils may still have difficulty summarizing the main ideas contained in the text. Constructing a table or diagram is an effective way to help pupils understand the meaning of "to need"; it forces them to examine a passage which distinguishes key words and principal actions. Tables and diagrams use images rather than words, and the images are gradually replaced by symbols. Furthermore, the direction of actions, are represented by adjustable arrows. Tables and diagrams can be useful in illustrating the concept of a chain or a cycle; they should be considered learning models which pupils are more likely to remember than the underlying concepts being represented. Furthermore, the representations of a cycle or chain which pupils form in their minds should serve as a model that will be useful to them in other situations.

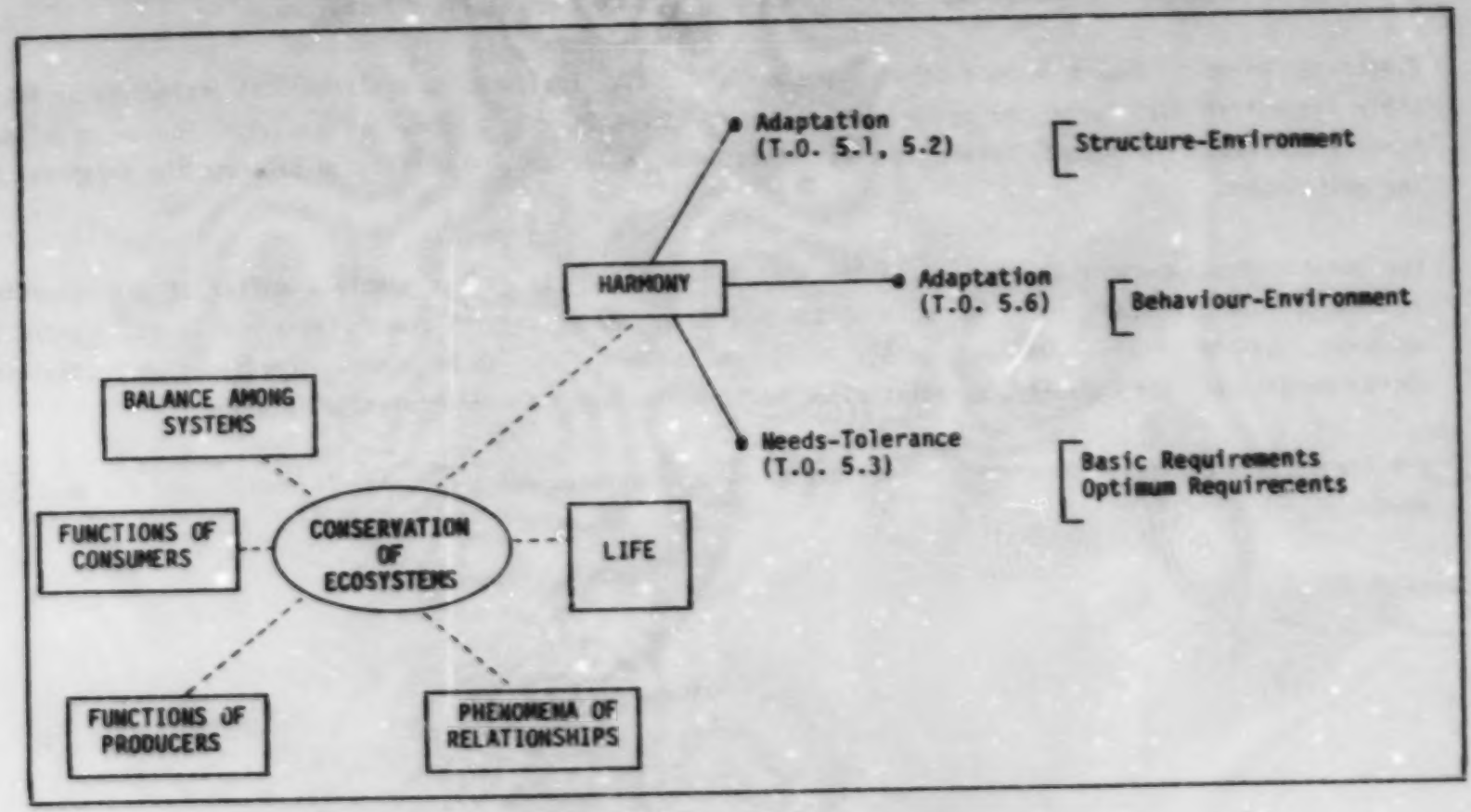
CONTENT	TERMINAL OBJECTIVE: 4.6 to 4.10	LEARNING ACTIVITIES
The transfer of energy within an ecosystem is based on a model of functional interrelationships. The ecological system brings all of nature's cycles into play. It extends the food chain by elevating the status of producers, decomposers and nonliving things in relation to consumers. A cycle is a representative model of the environment. Far from being static, the environment is in a constant state of flux. Energy is transferred from one organism to another according to a set of well-known basic principles. These principles follow various rhythms determined by numerous factors and are expressed in terms of loss and productivity ratios. In nature, all observable phenomena can be explained as part of an ongoing effort to establish and maintain a state of equilibrium. Producers, consumers and decomposers each have specific roles to play and strive to maintain a b[illegible] their various interrelationships [illegible] representation of the ecologica[illegible] the food pyramid. The balance existing between each of the pyramid's different levels brings to mind struggles for survival in terms of population density and carrying capacity.		At this stage in the course, pupils should become more familiar with the use of diagrams involving codes and symbols. Developing this skill will enable pupils to answer questions by deriving explanations from tables or diagrams. The word "balance" appears most frequently in the language of mathematics and statistics. Pupils can therefore gain a better understanding of this important concept by playing mathematical games of skill based on realistic situations. The concepts of balance and imbalance are equally difficult to grasp. On the other hand, an understanding of the terms population density and carrying capacity can be facilitated by matching pairs of correlated words like producers and herbivores or herbivores and carnivores.

CONTENT	TERMINAL OBJECTIVE: 4.6 to 4.10	LEARNING ACTIVITIES
The system model corresponds well to the natural environment but it cannot be applied to the environment of humans. In fact, when describing the man-made environment, it is far more appropriate to speak in terms of lack of equilibrium. For example, the system for manufacturing a given food for the North American consumer involves the use of a far greater supply of energy than that which is contained in the food itself.		

CONTENT	TERMINAL OBJECTIVE: 4.11 - 4.12	LEARNING ACTIVITIES
Pupils should gradually realize that the elements of nature are not static and separate entities as objects in a museum, but instead form a unity of interrelated components. Any significant change occuring at one level of the ecological system can mean disaster for the unit as a whole. To express concern about waste or overconsumption is not to deny progress or the development of natural resources. Furthermore, an ecologically-minded society does not imply a return to the Dark Ages; it merely indicates a desire to reconcile conservation with progress, basic needs with personal well-being and social rights with the rights of individuals. The limits of an ecosystem are well defined: the quantity of matter and energy that comes out must be equal to the quantity that goes in. Within these limits there is a built-in control mechanism which maintains a certain stability or a general predisposition towards balance.		The chosen learning situation should be consonant with the system model proposed in this module. Teachers should try to apply this model to the activities of human beings in the industrialized world. Topics for discussion should be selected from human activities that illustrate clearly the states of balance and imbalance. In reality, a state of balance can be maintained as long as things do not exceed a certain threshold. This threshold is difficult to delineate because various practices and activities related to people's value systems are deeply entrenched in their lives. Man's activities are becoming increasingly interdependent and complementary as a result of the widening distance between the areas of production, distribution and consumption. Popular beliefs may serve as an effective starting point in underlining the importance of respecting life and property, and in stressing the value of conservation as opposed to the harmful effects of waste and environmental degradation.

MODULE 5: ENVIRONMENTAL INFLUENCES ON LIVING THINGS

2.6 MODULE 5: ENVIRONMENTAL INFLUENCES ON LIVING ORGANISMS



THE Key CONCEPT: "Harmony"

Conservation requires a knowledge of the mechanisms by which organisms adapt to nature.

Plants and animals cohabit in an ecosystem and exhibit active responses to environmental influences by using their respective structures and by developing behaviours that enable them to survive. For an organism, harmony consists of a balance between the satisfaction of needs and the ability to tolerate the harshness of the environment.

For human beings, harmony is related to the quality of life. It is not simply a matter of improving the landscape, planting shade trees in front of the house, or having crystal clear rivers and lakes. Generally speaking, quality of life for human beings is linked to the ability to harmonize aspirations and activities (human needs) with the capacity to resist climatic hardships and environmental deterioration.

Quality of life derives from a state of balance or harmony between man's personal life style and his environment.

CONTENT	TERMINAL OBJECTIVE: 5.1 and 5.2	LEARNING ACTIVITIES
Any study of the components of an ecosystem must take into consideration the ability of living things to adapt to their environment. Organisms are adept at exploiting or making use of their specific structural features to resist the elements of the environment. Organisms are equipped with the necessary structures to overcome the actions of non-living things, having developed specific behaviours over the years that enable them to cope. For example, some have specific ways of obtaining food, others have developed original reproductive mechanisms.		The recommended method for achieving the objectives of this learning activity is problem-solving, a combination of description and analysis. The focus of learning is the role of a specific structure of a given organism (plant or animal). This approach helps pupils draw a conclusion about a given organism's structural organization based on the observation of a few simple details, and avoids any of the systematic study involved in zoology or botany. When choosing topics for observation from the wide range of choices available, the teacher should give preference to topics of particular local interest. This sequence lends itself well to field observation, but it is important that pupils be discouraged from collecting samples except, for example, in the fall when leaves may be collected without harming the environment.

CONTENT	TERMINAL OBJECTIVE: 5.3	LEARNING ACTIVITIES
Plants and animals use all their resources to ensure their survival. Throughout their lives, organisms are constantly subjected to the changing conditions of their environment. Their development will be harmonious to the extent that their needs are adequately met. However, the ambient conditions, particularly those related to climate, are not always ideal, forcing organisms to adapt in order to survive. As a result, over time, living things have developed a certain tolerance with respect to the satisfaction of their needs. A distinction can be made between optimal requirements, which when met provide for an organism's ideal growth, and basic requirements, which under extreme conditions are the minimal requirements necessary to ensure an organism's survival. Some concrete examples of experimentation related to this topic are discussed in the section on Terminal Objective 5.7.		The activities in this sequence are designed to provide a follow-up to Terminal Objectives 2.5, 3.5 and 4.2 of the preceding modules. The learning activities proposed in this exercise are more than simple controlled exercises and therefore call for a greater degree of attention and resourcefulness on the part of the pupils. It is still advisable to offer certain pupils explicit instructions in order to avoid problems. Pupils should, however, be required to formulate some assumptions and establish their own work methods. Moreover, they should be encouraged to interpret the results of all their experiments, whether successful or not; pupils should learn to make good use of all experimental conditions and attempt to find plausible explanations.

CONTENT	TERMINAL OBJECTIVE: 5.4	LEARNING ACTIVITIES
No matter where he lives, man is always surrounded by living things, although he is not always aware of their existence. And yet, regularly, without fail, signs of life emerge everywhere. Like perpetual motion, their emergence is part of a life cycle that is more or less active, depending upon local climatic conditions. Thus, the bud of an apple tree, though seemingly lifeless during winter, bursts open with the advent of milder spring temperatures. The bud's special structure enables it to resist the bitter cold during the winter season. Similarly, in the springtime, swarms of mosquitos emerge from lake surfaces after having lived a camouflaged existence during the winter months. They too are equipped with special structures to resist the cold.		The comments made in the preceding objective (5.3) also apply here.

CONTENT	TERMINAL OBJECTIVE: 5.6 and 5.7	LEARNING ACTIVITIES
An organism's ability to adapt is made possible by the structures and behaviours which enable it to obtain food, protect itself, build shelters, etc. An organism makes full use of the benefits afforded by its structures while expending the least possible amount of energy. Adaptation is simply a compromise between needs and tolerance; it follows the basic laws of energy efficiency. If it is to survive, an organism needs to be able to overcome the negative effects of nonliving elements. An organism which has the necessary structures to do so also develops the necessary behaviours to overcome these effects with the least possible effort.		The content of this sequence will help pupils develop a higher level of independence. The learning activities require concentration, investigation and consultation of reference material. Pupils should make use of all available equipment and materials to help them expand their knowledge. This objective is an extension of the documentation sequences presented in the preceding modules. The teacher can be more effective in his/her role as an instructor by allowing pupils increasing freedom in carrying out their activities and by offering the guidelines, suggestions and materials necessary for their individual progress. The teacher should place greater emphasis on the overall approach to learning rather than on the content of the specific activity; this will allow pupils more flexibility to progress at their own pace.

CONTENT	TERMINAL OBJECTIVE: 5.8 and 5.9	LEARNING ACTIVITIES
In the future, human beings must conduct their activities with greater concern for everything that surrounds them. If man wishes to preserve his living space, it is imperative that he change the ways in which he exploits the resources of the environment. The alarming rate at which waste is increasing and natural resources are being depleted calls for a careful reevaluation of today's lifestyles. Man can still regain a dimension of harmony in relation to his environment if he learns to respect life in all of its forms. Building a new value system will help to trigger the necessary transition from a "consumer" to a "conserver" society.		In this module, considerable attention has been focused on the study of behaviours and of various forms of adaptation. Understanding these is fundamental to the acquisition of a new value system because there are certain similarities between the natural and the built or man-made environment which make it possible for pupils to transfer their knowledge of one to the other. The teaching strategies should aim to effect certain changes in pupils' behaviour by fostering changes in their attitude. This approach is linked to people's cultural values, for human activities are generally directed towards growth and development which, ideally, should correspond to the satisfaction of needs. In keeping with the goals and general objectives of the program, teaching should ultimately aim to develop the pupils' ability not only to identify facts, but also to seek explanations of phenomena and to anticipate possible consequences of certain actions.

EVALUATION

3. EVALUATION

The evaluation procedure selected for Ecology has been carefully selected to complement the instructional approach outlined in Section 7.3 of the Ecology course. This procedure comprises four specific phases.

Phase 1 concentrates on identifying the reasons for the evaluation. Phase 2 is concerned with what should be measured and stipulates that "the measurement instruments should be designed to take into consideration not only the content on which the objectives are based, but also the skills and attitudes which are included in the course."[1] Phase 3 focuses on the actual construction of the measurement instrument according to the criteria of correspondence, clarity and relevance. Finally, Phase 4 deals with the question of how the measurement results should be interpreted.

Further information regarding formative evaluation may be found in the Ecology Formative Evaluation Guide, Code 16-7221-02A.

---

1 Gouvernement du Québec. Ministère de l'Éducation. Direction générale du développement pédagogique, Secondary School Curriculum: Ecology, Document No. 16-3143-01A (Québec, 1983), p. 47.

BIBLIOGRAPHY

BIBLIOGRAPHY

ASTOLFI, Jean-Pierre et al. Quelle éducation scientifique pour quelle société? Paris: Presses Universitaires de France, 1978.

Biologie (Initiation expérimentale en 6° et 5°) dans les C.E.S. expérimentaux. Paris: Recherche Pédagogique (I.N.R.D.P.) Brochure No. 55, 1972, pp. 57-66.

Biology Today, Its Role in Education. Report of an OECD Working Session on the Teaching of School Biology. Hellebaeck (Denmark), June 1964. Paris: OECD, 1966.

BLAIS, Martin. L'échelle des valeurs humaines. Montréal: Fides, 1980.

BLOOM, Benjamin S. Taxonomy of Educational Objectives - Handbook 1: Cognitive Domain. New York: David McKay Co. Inc., 1956.

BOURRON, Yves. Audio-visuel, pédagogie et communication. Paris: Éditions d'organisation, 1980.

BROUILLET, Guy. "Propositions de valeurs pour l'école québécoise." Conference of La semaine nationale de la Direction générale du développement pédagogique. Québec, Université Laval, May 1980.

BRUNER, Jerome S. and David R. OLSON. "Learning Through Experience and Learning Through Media." Prospects: Quarterly Review of Education, Vol. 3, No. 1, Spring 1973, pp. 20-38.

BURNS, Richard W. New Approaches to Behavioral Objectives. 2nd ed. Dubuque, Iowa: W.C. Brown & Co., 1972.

DE CLOSETS, François. Le bonheur en plus. Paris: Éditions Denoël, Bibliothèque Médiations, 1974.

DE LANDSHEERE, Viviane and Gilbert. Définir les objectifs de l'éducation. Paris: Presses Universitaires de France, Collection Pédagogique d'aujourd'hui, 1975.

DE ROSNAY, Joël. Le macroscope - Vers une vision globale. Paris: Éditions du Seuil, Collection Points, 1975.

DUBOS, René. Choisir d'être humain. Paris: Éditions Denoël, Bibliothèque Médiations, 1977.

DUBOS, René. "Une médecine si humaine." L'Express. Paris, 3 Nov. 1979, pp. 92-104.

DUMONT, René. L'utopie de la mort. Paris: Éditions du Seuil, Collection Points, 1974.

DUNETON, Claude. Je suis comme une truie qui doute. Paris: Éditions du Seuil, Collection Points, 1976.

ELSTGEEST, Jos. "Trends in Environmental Education." Prospects: Quarterly Review of Education, Vol. 1, 1978, pp. 66-72.

GAGNÉ, Robert M. Essentials of Learning for Instruction. New York: Holt, Rinehart and Winston, 1974.

Gouvernement du Québec. Conseil Supérieur de l'éducation du Québec. Connaissances des principaux modèles théoriques d'éducation. Québec, 1974.

Gouvernement du Québec. Ministère de l'Éducation. Direction des programmes. Projet d'orientation de l'éducation scientifique au niveau secondaire au Québec. Phase 1 and phase 2, 1978.

GUSDORF, Georges. Pourquoi des professeurs? Paris: Petite bibliothèque Payot, 1977.

HALL, William C. "Integrated Science." Prospects: Quarterly Review of Education, Vol. 8, No. 1, 1978.

ILLICH, Ivan. Le chômage créateur. Paris: Éditions du Seuil, 1977.

JURDENT, Michel. Les insolences d'un écologiste. Québec: Les éditions du Boréal Express Ltée., 1976.

KRATHWOHL, David R. et al. Taxonomy of Educational Objectives - Handbook II: Affective Domain. New York: David McKay Co. Inc., 1964.

MAGER, Robert F Preparing Objectives for Programmed Instruction. San Francisco: Fearon Publishers, 1984.

MAHEU, René. "For a Human Environment." Prospects: Quarterly Review of Education. Vol. 2, No. 4, Winter, 1972, pp. 446-448.

OUELLET, André. "Importance des valeurs dans l'apprentissage des sciences." Spectre, Bulletin pédagogique de l'Association des Professeurs de Sciences du Québec (A.P.S.Q.) Vol. 8, No. 1, Dec. 1978, pp. 33-35.

SCHUMACHER, E.F. Small is Beautiful: Economics as if People Mattered. New York: Harper and Row, 1975.

Science Council of Canada. "Pour une Société de conservation." Québec: Québec-Science, Vol. 14, No. 10, 1976, pp. 23-30.

STAPP, William B. "An Instructional Model for Environmental Education." Prospects: Quarterly Review of Education, Vol. 8, No. 4, 1978, pp. 495-507.

TOFFLER, Alvin. The Third Wave. New York: Morrow, 1980.

UNESCO. "New Trends in Biology Teaching." Prospects: Quarterly Review of Education, Vol. 4, 1977.

UNESCO. Trends in Environmental Education. Paris: Unesco, 1977.

VALASKAKIS, Kimon. The Conserver Society: A Blueprint for the Future. New York: Morrow, 1980.

VIEL, Jacques and Paul Darveau. An Ecological Perspective. Translated from French by Jeffrey Holt. Montréal: Guérin, 1984.

AUDIO-VISUAL MATERIAL

Ecology Close-Up. O.S.T. Videocassette. Developed by Direction de la production et de la distribution du matériel didactique. Ministère de l'Éducation du Québec and Radio-Québec, 1982. Six 30-minute programs.